Minerals yearbook: Metals, minerals, and fuels 1972. Year 1972, Volume 1 1972

Bureau of Mines
Washington, D. C.: Bureau of Mines : United States Government Printing Office, 1972

https://digital.library.wisc.edu/1711.dl/PPYAWXJZXOESO8L

Minerals Yearbook 1972

Volume I

METALS, MINERALS, AND FUELS

Prepared by staff of the

BUREAU OF MINES

UNITED STATES DEPARTMENT OF THE INTERIOR • Rogers C. B. Morton, Secretary

BUREAU OF MINES • Thomas V. Falkie, Director

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

WASHINGTON : 1974

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price $12.15

Foreword

For 91 years, the Federal Government, through the medium of the Minerals Yearbook or its predecessor volumes, has reported annually on mineral industry activities. This edition of the Minerals Yearbook presents the record on worldwide mineral industry performance during 1972. In addition to statistical data, the volumes provide sufficient background information to interpret the year's developments. The content of the individual volumes is as 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 statistical summary, and a chapter on technologic trends.

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, the Commonwealth of Puerto Rico, and the Canal Zone. 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 minerals in general and their relationships to the world economy.

The Bureau of Mines continually strives to improve the value of the Yearbook for its users, and toward that end, the constructive comments and suggestions of readers will be welcomed.

THOMAS V. FALKIE, *Director.*

Acknowledgments

Volume I, Metals, Minerals, and Fuels, of the Minerals Yearbook summarizes the significant data pertaining to mineral commodities obtained as a result of the mineral intelligence gathering activities of the divisions and offices of the Assistant Directorate—Mineral Supply.

The collection, compilation, and analysis of the data on the domestic minerals and mineral fuel industries were performed by the staffs of the Divisions of Ferrous Metals, Fossil Fuels, Nonferrous Metals, and Nonmetallic Minerals. Statistical data were compiled by the statistical staffs of these Divisions from information supplied by mineral producers, processors, and users in response to production and consumption canvasses, and their voluntary response is gratefully acknowledged. 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. The foreign trade data for the United States were obtained from reports of the Bureau of the Census, U.S. Department of Commerce. World production and 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 direction 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 the supporting information appearing in the Minerals Yearbook by numerous cooperating State agencies. These organizations are listed in the acknowledgment to Volume II.

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

Contents

Review of the Mineral Industries

By Daniel E. Sullivan,[1] Jeannette I. Baker,[2] and Nicholas G. Theofilos[3]

The U.S. economy was expansive in 1972. Output, income, and employment all increased substantially. The unemployment rate declined only slightly. Inflation moderated but not for food commodities. Monetary policy was loose at the beginning of the year but tightened somewhat in the closing months. Fiscal policy was also expansive. During 1972, Phase II controls on prices and wages were in effect. This allowed fiscal and monetary policy to be more flexible.

Output as measured by the gross national product (GNP) increased 9.75% in 1972. Real GNP grew at a rate of 6.5%, the largest full-year advance since 1966; and the implicit price deflator rose 3.8%, the smallest full-year advance since 1966. All major sectors except for net exports contributed to the overall increase. Significant increases occurred in gross private domestic investment, Federal purchases in the first half of the year, and consumer spending. The Federal Reserve Board (FRB) Index of Industrial Production increased more than 7%.

Employment in 1972 continued the strong growth trend that characterized the second half of 1971. However, the labor force also increased substantially so unemployment declined only slightly from 5.9% in 1971 to 5.6% in 1972. Unemployment was close to the 1971 level in the first 5 months of the year, but by the fourth quarter it had declined to an average of about 5.3%. The increase in employment was strongest in the durable goods manufacturing industries. The increase in the labor force was greatest for adult women.

The rate of inflation in 1972 was less than that of 1971 for most commodities. Agricultural prices not covered by price controls increased at an accelerated rate during 1972. The overall consumer price index was up 3.3% for the year, compared with 4.3% for 1971. With food prices excluded, the index increased 3.0%. Prices for nonfood commodities were up 2.3% for the year 1972, compared with 3.8% for 1971. Service prices rose 3.8% for 1972, which was less than for recent years. Wholesale prices increased at a greater rate during 1972 than during 1971 wholly because of increases in the prices of agricultural products. The industrial wholesale price index rose about the same during 1972 as for the previous year, 3.4%.

Monetary policy during the year favored economic expansion. Its purpose was to contribute to the goals of economic growth, increased employment, less inflation, and fewer balance of payments problems. The money supply grew at a rate of 8.2% during 1972, the second highest rate since World War II. In 1971 the increase was 6.2%, and in 1970, it was 5.4%. Interest rates were stable in 1972 after declining in late 1971. Mortgage interest rates in 1972 were below those of 1971, and well below those of 1970.

An expansionary Federal fiscal policy resulted from rising expenditures and from the effect of tax reductions instituted in 1971 and 1972. In 1971 there was a small full employment surplus, but in 1972 there was a stimulating full employment deficit.

United States gold reserves declined slightly early in 1972 and then remained constant until May when their value was increased by a change in the price of gold from $32 to $38 per troy ounce. The rest of the year they remained almost unchanged with a slight decline at the end of the year.

Significant Federal activity in 1972 included the continuation of Phase II of the New Economic Policy (NEP). Phase II

[1] Economist, Office of Economic Analysis—Mineral Supply.
[2] Commodity research specialist, Office of Technical Data Services—Mineral Supply.
[3] Statistical assistant, Office of Economic Analysis—Mineral Supply.

was designed to be a transition between the freeze of Phase I and less stringent controls. Legislation approved by Congress during 1972 covered many subjects of concern to the minerals industries. These included the environment, water, public land, black-lung disease benefits, consumer safety, the price of gold, and the strategic stockpile.

Bureau of Mines research programs continued to be directed toward developing more effective, efficient and less costly extraction, processing, and utilization techniques; improving mine safety; increasing the recovery of secondary resources; and eliminating pollution problems.

The demand for energy continued to be strong, especially for clean-burning fuels. Domestic fuels production expanded at a slower rate than consumption, more fuels were imported, and there were some fuel shortages. Underground mining of coal declined for the third consecutive year primarily because of health and safety regulations. Surface mining increased, and, for the first time in the history of the industry, output from strip mines exceeded that of deep mines. In petroleum, major concerns were import quotas and the construction of the trans-Alaska pipeline. The pipeline would bring Alaskan oil to the contiguous 48 States, but unsettled environmental decisions have delayed its construction.

The metals industry reflected the economy as a whole in 1972. Prices increased as did the demand for metals. There were no major strikes, but concern over environmental problems was widely felt. Output in the nonmetallic mineral industries was high during 1972, despite the fact that environmental problems were significant throughout the industry.

The long-run growth in world trade was maintained in 1972 in spite of turmoil in the international monetary system. The outlook for future modifications in the system appeared good. U.S. balance of payments improved in 1972, although a large deficit still remained.

SOURCES AND USES

ALL MINERALS

Production.—In 1972, domestic production of primary minerals and mineral fuels was valued at $32.2 billion. In 1967 constant dollars, the value of mineral production was $27.0 billion. The value of metals and nonmetals each increased about 7% and mineral fuels advanced 4% over 1971.

The Bureau of Mines total index of physical volume of mineral production (1967=100) increased 2.5% to 112.6 points in 1972. The average for metals increased 4.3% to 127.5 points. Within this group ferrous metals increased 1.5% and nonferrous metals increased 5.7%. In the nonferrous index, base metals increased 7.8%, monetary metals declined 5.4%, and other nonferrous 2.7%. The average for nonmetals increased 5.8%. Construction, chemical, and other nonmetals increased at rates

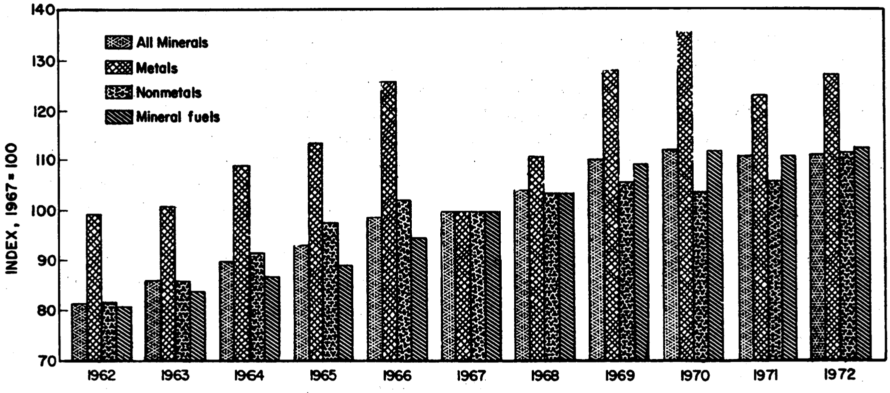

Figure 1.—Indexes of physical volume of mineral production in the United States, by group.

close to the average with the former increasing at a less than average rate and the latter two increasing more than the average. The index for fuels increased 1.2%. The coal index increased 6.2%, and crude oil and natural gas increased from 111.3 to 111.4 points.

The FRB Index of Industrial Production (1967=100) increased more than 7% during 1972, from 106.8 to 114.4 index points. The average for all mining increased from 107.0 to 108.2 index points because of increases in coal mining and stone and earth minerals mining. The former increased over 3%; the latter increased almost 1%. The index for crude oil declined 0.9%, gas and gas liquids declined more than 1%, and metal mining declined only 0.5%.

Industrial production of metals and nonmetals increased significantly in 1972. Primary metals, iron and steel, and nonferrous metals and products increased 12%, 11%, and 14%, respectively, after declining last year. Clay, glass, and stone products, which increased 3% in 1971, increased 7% in 1972.

The FRB monthly indexes of mining production (1967=100) stayed near 108 index points during most of the year except for September, October, and November when it was near 110 index points. The index for coal was mixed during 1972; in July it reached a high of 114.4 points, and in August it came within 0.1 point of the December low of 97.1 points. Crude oil and natural gas increased early in the year and remained fairly level through the rest of the year. Metal, stone, and earth minerals increased for the year after an early decline.

The net supply of principal minerals increased for most commodities during 1972. Ferrous metals followed this trend with pig iron increasing 9.9% to 89,670,000 tons, and steel ingot increasing 9.0% to 147,853,000 long tons. Iron ore, not following the trend, declined 2.3% to 111,545,000 long tons. Of the other ferrous metals, chromite and manganese declined 13% or more while the rest increased. The total net supply of tungsten doubled. Nonferrous metals also followed the trend, with antimony and the platinum-group metals increasing by the greatest margin. The only significant declines in this group were in mercury, rutile, and zinc. Almost all nonmetal group commodities showed increases in net supply, with the exception of sand and gravel, which declined 0.8%. Gypsum and crude barite showed the greatest increases, 23.1% and 16.9%, respectively. The smallest increases were posted by potash, salt, and sulfur.

Stocks and Government Stockpile.—The Bureau of Mines index of stocks of crude minerals (1967=100) for metals and nonmetals declined 4.0% to 142 points in 1972. Metal stocks declined 2.7% to 143 points. Iron ore declined 16.9%. Other ferrous ores increased 156% in 1972, compared with a 196% increase in 1971; both increases were caused by a large increase in molybdenum stocks. Nonferrous metal stocks declined 22.8% to 78 points. Nonmetallic stocks declined 5.4% to 141 points. The index of stocks held by mineral manufacturing consumers and dealers declined 8 points to 95 points in 1972. Metal stocks declined 11 points as all metal subgroups declined at least 8 points with the exception of other ferrous metals stocks, which remained constant. Iron declined 14 points. The index for nonmetals increased 33 points to 121.

Producer stocks of bituminous coal and lignite increased 28% in 1972; coke stocks decreased 17.0%. Stocks of petroleum and related products, with the exception of petroleum asphalt, all declined. Petroleum asphalt increased 2.0%. Crude petroleum decreased 5.1% and gasoline stocks decreased 3.0%. Natural gas stocks remained unchanged in 1972.

The seasonally adjusted book value of product inventories for selected mineral processing industries increased as a whole in 1972 although some industries showed declines. Energy showed a decrease in inventories, and nonmetals and primary metals showed increases in inventories. Petroleum and coal products decreased 9.6% to $2,200 million as of December 1972. Stone, clay, and glass products increased 5.2% to $2,381 million in 1972. The seasonally adjusted book value of primary metals inventories increased 4.6% to $9,619 million. Blast furnace and steel mills inventories, which make up almost 55% of primary metals inventories, increased 9.3%. Other primary metals inventories declined less than 0.5% to $4,375 million. The total seasonally adjusted book value of inventories for selected mineral processing industries increased 2.2% to $14,200 million during the year 1972.

The national stockpile of strategic materials continued to contain an important component of the Nation's mineral supply during 1972. Stockpile commodities of significant market value included aluminum, metallurgical chromite, copper, lead, metallurgical manganese, silver, tin, tungsten, and zinc.

Exports.—The total value of selected minerals and mineral products exported in 1972 was $4,691 million, a 2.3% increase over the comparable 1971 figure. Exports in 1971 had declined more than 21% from those of 1970. The increase was felt in most sectors except for chemicals, which declined 9.3%. Minerals, nonmetallic (crude), exports increased 9.8%. Exports of metals (crude and scrap), mineral energy and related products, and metals (manufactured), all increased at rates close to 4%. Minerals, nonmetallic (manufactured), exports increased 2.6%.

Significant changes in the geographical distribution of selected mineral exports took place in 1972. Last year the Soviet bloc received less than 0.5% of U.S. crude fertilizer exports; in 1972, they received 3%. In 1971 other North American countries received 47% of U.S. exports of petroleum, crude and partially refined; in 1972 they received only 29%, with most of the difference accounted for in exports to Asia. In 1971, 85% of tin and tin alloys was exported to Asia; in 1972 Asia received only 10% of U.S. tin and tin alloys exports. In 1971, 88% of the uranium and thorium and their alloys exports was shipped to North America, but in 1972 only 26% of these exports went to other North American countries and 62% was shipped to Europe.

Imports.—The value of selected mineral imports increased 18.5% to $11,646 million in 1972. All major categories except metals (crude and scrap) increased. Crude nonmetallic minerals increased 7.7% in value to $298 million. Crude and scrap metals declined 2.6% to $991 million. The most important increase was a 30.4% change, to $4,814 million, in the imports of mineral energy resources and related products. Within this group, crude and partly refined petroleum increased 39.3% to $2,593 million. Imports of chemicals increased 25.0% to $541 million. The largest percentage change was a 44.7% increase in the imports of minerals, nonmetallic (manufactured), to $221 million. Imports of metals (manufactured) increased 12.2% to $4,781 million.

The geographical distribution of the source of imports into the U.S. in 1972 changed significantly for certain mineral commodities. In 1971 other North American countries were the source of 66% of copper ores and concentrates imported into the U.S. In 1972 North America was the source of only 14%; Asia, which had supplied none in 1971, supplied 56% of these imports. Other North American countries supplied 34% of the imports into the U.S. of tin waste and scrap in 1971, and Africa supplied 36%; but in 1972 Africa supplied none, and North American countries supplied 71%. In 1971 North American countries supplied 57% of the aluminum waste and scrap imported, and Europe supplied the remainder; but in 1972 North American countries supplied 88% of these imports. Sixty-two percent of imports of tungsten ores and concentrates in 1971 were from North American countries; in 1972 only 30% came from North America, while imports from Asia increased from none to 25% of the total. Imports of mercury, including waste and scrap, decreased from 81% from North American sources in 1971 to 59% in 1972; imports from Africa increased from none to 17%.

Consumption.—Consumption of major mineral products generally increased during 1972. Iron ore consumption increased 9.2% after declining 11.6% in 1971. Raw steel increased 10.6%. All other ferrous metals showed strong increases in consumption. All nonferrous metals increased except uranium, which declined 9.4%. Platinum-group metals consumption increased 23.2%. Antimony and silver both increased 17% or more. Copper and zinc each increased almost 11% and ilmenite and titanium slag increased more than 10%. Lead increased 3.7% but mercury increased only 1.2%.

Consumption of nonmetals increased for all major commodities except sand and gravel, which declined 0.8%. Phosphate rock increased 9.6%, followed by cement, which increased 9.0%. Sulfur increased 7.2%; asbestos, 6.6%; crushed stone, 5.6%; clays, 4.9%; and lime, 3.6%. Salt and potash increased only 0.8% and 0.4%, respectively.

Total energy resource inputs in terms of British thermal units (Btu) increased 5.2% to 72,242 billion Btu. Consumption of all mineral energy resources increased with one exception—anthracite coal declined over 14%. Petroleum consumption increased 7.9%, bituminous coal increased 5.1%, and dry natural gas increased 1.3%.

All categories of electricity generation increased in 1972. The total increased 7.9% to 1,853 billion kilowatt hours. Utilities increased 8.3%, made up by a 3.9% gain in hydropower, a 42.6% gain in nuclear power, and an 8.5% increase in conventional fuel-burning plants. Industrial generation of electricity increased 2.4%.

ENERGY

Demand for energy in 1972 was at the highest level ever. Domestic production did not supply as great a percentage of the U.S. supply as it has in the past. The demand for clean energy has increased faster than the demand for energy as a whole or the ability to produce clean-burning fuels. As a result there was in 1972, as in the previous few years, an "energy crisis." This energy crisis was generally manifested in the form of "brown outs" and shortages of heating fuel in the cold months. As a result, more of the domestic energy needs in 1972 were supplied by imported fuels, and the search for alternative sources of domestic energy was intensified.

Production.—Total production of mineral energy resources and electricity from hydropower and nuclear power in 1972 increased 2.1% to 62,222 trillion Btu. Fossil fuels increased, except for anthracite coal, which declined 18.5% to 181 trillion Btu. Bituminous coal and lignite increased 7.2% to 14,350 trillion Btu. Wet natural gas and crude petroleum both increased less than 0.5% to 24,878 and 19,344 trillion Btu, respectively. Hydropower increased 2.4% to 2,893 trillion Btu, and nuclear power increased 42.6% to 576 trillion Btu.

Consumption.—U.S. energy consumption in 1972 increased 5.2% to 72,242 trillion Btu. Consumption of anthracite coal declined over 14.3%. Bituminous coal and lignite increased 5%, second only to petroleum, which increased over 8% in 1972. Natural gas consumption increased over 1%, and natural gas liquids increased over 2%. Consumption of electricity from hydropower increased almost 4%. Electricity consumption from nuclear power, which was the same as production, increased 42.6%.

Household and commercial received 41.9% of its total energy inputs from natural gas, 36.9% from petroleum, and 19.1% from electric utilities; for industrial users the percentages were 45.9, 24.3, and 10.8, respectively. The transportation sector received 95.5% of its energy from petroleum. Energy inputs to electric utilities were from bituminous coal and lignite, 41.9%; dry natural gas, 22.1%; petroleum, 16.9%; hydropower, 15.8% and nuclear power, 3.1%.

Coal.—The domestic supply of anthracite coal declined 19.4% in 1972; that for bituminous coal and lignite increased 5.0%. Exports of anthracite declined 14.3% and those of bituminous declined 1.2%. Imports of bituminous coal declined 64,000 tons to 47,000 tons in 1972, after increasing 75,000 tons in 1971. The total domestic supply of bituminous coal in 1972 was 519.8 million tons; for anthracite the figure was 5.9 million tons. Electric utilities used 67% of bituminous coal. The household and commercial sector was the largest user of anthracite.

Natural gas.—The domestic supply of natural gas increased 1.3% to 22,429 billion cubic feet in 1972. Domestic production increased 0.2% to 22,532 billion cubic feet. Exports declined 2.7% to 78 billion cubic feet; imports increased 9.1% to 1,019 billion cubic feet. Demand for natural gas increased in all consuming sectors except electric power generation, which declined 0.4%. The largest increase was 3.8% in the household and commercial sector. The largest consuming sector, industrial, consumed 42.9% of the natural gas supply in 1972.

Petroleum.—The domestic supply of petroleum increased 7.9% to 5,990.2 million barrels. Production increased only negligibly to 3,455.4 million barrels; exports declined from 0.5 to 0.2 million barrels; and imports increased 32.2% to 811.1 million barrels. The total supply of crude oil increased 4.7% to 4,280.9 million barrels. Demand for petroleum increased 7.7% to 5,320.7 million barrels. Transportation continued to be the largest consuming sector, accounting for over 60% of petroleum demand.

Geothermal Energy.—The search for new sources of energy has led to the development of geothermal power generation. At the present time it is in use at only a few locations where ideal conditions exist. Other areas considered potential sources of geothermal power were being investigated in 1972.

Nuclear Energy.—Nuclear energy in 1972 contributed less than 1% to total energy consumption in terms of Btu's. Although this is not an impressive number, during 1972 much research was devoted to increasing the energy output from nuclear sources.

Hydroelectric Power.—Hydroelectric power supplied less than 5% of U.S. consumption in 1972. During the year, the increase in the output of hydroelectric plants did not keep up with the rate of increase in the U.S. demand for energy.

Other Energy.—Solar, wind, tidal and biological energies were only minor, or potential sources during 1972. All were being considered as potential sources of energy for the future. Solar and wind energy have been used on only a minor scale. Biological (from organic wastes) and tidal energies were still only in the theoretical stages in 1972.

EMPLOYMENT AND PRODUCTIVITY

Employment.—Employment in selected mineral industries increased for mining, but the manufacturing sector continued to show a decrease for the third consecutive year. Total mining employment increased almost 1% in contrast to last year's decline of 3%. This was mostly accounted for by a 12% increase in copper ore mining and an 8% gain in bituminous coal. Employment in crude petroleum and natural gasfields posted a 2.3% decrease, while oil and gasfield services registered a 3.2% gain. Iron ore mining and nonmetal mining and quarrying employment continued to decline to 20,100 and 112,100, respectively.

In 1972, minerals manufacturing employment decreased almost 2% to 834,800. All categories declined except for cement and petroleum and coal products.

Hours and Earnings.—Hourly earnings for the total mining sector increased 7.8% to $4.17. This increase is slightly better than the trend of recent years. Weekly earnings increased at almost the same rate, since weekly hours declined only 0.1 hour to 43.4. Average hourly earnings for metal mining increased 8.5% to $4.47. Average hourly earnings for iron ore mining increased 7.4% to $4.50, and for copper ore mining they increased 11.1% to $4.62. Average weekly hours for metal mining declined 0.1 hour to 41.5. Average weekly hours for copper ore mining declined 3% to 41.6, and an increase of 1.7% to 41.2 was reported for iron ore mining. Average hourly earnings for nonmetal mining and quarrying increased 7.3% to $3.95; weekly hours remained nearly the same; and weekly earnings increased almost the same percent as hourly earnings. In the mineral fuels industries, average hourly earnings increased 7.3% to $4.53, weekly hours remained constant, and weekly earnings increased 10.2% to $191.27. The highest average hourly and weekly earnings occurred in the bituminous coal mining industry. Weekly hours, weekly earnings, and hourly earnings all increased for crude petroleum and natural gas. Hourly earnings, which declined 2.1% last year, increased 5.9% this year.

Average hourly earnings for manufacturing industries increased 11.8% in 1972. Hourly earnings in the fertilizer industry increased 7.3% to $3.36; weekly earnings increased at a slightly higher rate; and weekly hours increased slightly. In the cement industry hourly earnings increased at about the same rate as last year (10%), to $5.12. Hourly earnings increased 12.7% to $5.15 for the blast furnaces, steel and rolling mills industry; weekly earnings increased 15.8% as weekly hours increased slightly over 1 hour. Hourly earnings in nonferrous smelting and refining increased 10.4%; weekly earnings increased 11.2%; and weekly hours increased only slightly.

Hourly earnings for the petroleum and related products industries increased 8.1% to $4.95. Weekly earnings increased 7.6% as weekly hours declined slightly.

Labor Turnover Rates.—The accession rate (hires and rehires) for selected mineral industries varied in 1972. Two categories remained stable, but three others declined. Of those showing a decline, blast furnaces, steel and rolling mills, and hydraulic cement, decreased by four per thousand employees; and coal mining went from 19 to 18 per thousand employees. Manufacturing, nonferrous smelting and refining, metal mining, iron ores, and copper ores registered moderate increases. The separation rate remained stable in manufacturing, petroleum refining and related industries, and petroleum refining. Separation rates in the metal mining, iron ore, and coal mining industries increased two per thousand over that of 1971. Hydraulic cement, copper ores, and blast furnaces, steel and rolling mills declined, with the latter showing the sharpest decrease. The layoff rate for 1972 was down or stable in most categories with the exception of coal mining, metal mining, and iron ores.

Wages and Salaries.—During 1972 the total wages and salaries for all industries continued to trend upward. The increase was 9.3%, significantly higher than last year's 5.9%. In the mining sector, total wages and salaries reached $6.7 billion. Wages and salaries in manufacturing rose 9.4% to $175.8 billion, a large increase over last year's 1.5% gain. Average yearly earnings per full-time employee for all industries was $8,604, a 6.7% increase. The mining sector employees received an annual average of $10,320 in 1972, a 4% gain over 1971. Average earnings in manufacturing increased 6.9%, to $9,232.

Productivity.—Labor productivity indexes for selected minerals in 1971 (latest data available) showed mixed results. The petroleum refining indexes showed gains in productivity, and the bituminous coal and lignite mining indexes showed losses in productivity. The index of copper ore output per production worker increased in 1971 from 131.9 points in 1970 to 133.5 points (1967=100). The indexes of output per production worker man-hour for copper ore mined and recoverable metal mined increased 5.4% and 1.9%, respectively to 133.8 and 114.9 index points. The index of output per production worker man-hour for iron ore mined increased 2.0% to 119.6 points and the same index for usable ore increased 0.8% to 108.9 points. Productivity of petroleum refined as reflected in the indexes of output per employee, per production worker, and per production worker man-hour all reversed the down-trend of 1970 and increased in 1971; output per production worker man-hour increased 4.3% to 114.9 index points. Productivity of bituminous coal and lignite mining as reflected in these same indexes declined; output per production worker man-hour declined 1.3% to 102.5 index points.

PRICES AND COSTS

Index of Average Unit Mine Value.—The total index of average unit mine value (1967=100) increased 2.3% in 1972, to 120.3. The fuel index increased by 1.7%, metals increased by 3.3% and nonmetals increased by 3.6%. Ferrous metals increased by 3.7%. Nonferrous base metals and other nonferrous metals increased by 0.6% and 0.8%, respectively. Nonferrous monetary metals increased by 26.9% raising the average for all nonferrous metals by 2.9%. The increase in the nonmetals index was caused by a 4.7% increase in construction and a 4.9% increase in other metals; the chemical index declined 1.0%. The coal index increased 6.3%, and crude oil and natural gas increased 0.5%.

Index of Implicit Unit Value.—The index of implicit unit value (1967=100) increased 2.2% to 120.2 in 1972. This is less than one-half the increase of the previous year. The index for ferrous metals increased 3.3%. The average for nonferrous metals increased 2.1%, compared with the 7.9% decline in 1971. Base metals increased slightly, monetary metals increased almost 24% and other nonferrous metals increased 3.3%. Nonmetals increased 3.3% to 110.8. Construction increased 4.4%, chemicals declined 2.4%, and other nonmetals increased 5.2%. The fuels section increased 2.1% from 119.8 to 122.3. The coal index increased 6.4% and that for crude oil and natural gas increased less than 1%.

Prices.—The wholesale price index for all commodities increased 4.6% during 1972. However, the index for all commodities other than farm and food increased only 3.4%. Wholesale prices for metals and metal products increased 3.8%. Within this group, price changes ranged from a 16.6%

decline in aluminum ingot to a 10.7% increase in common pig lead. Prime western slab zinc increased 10.0%. Most other metals prices increased moderately. Prices of most nonmetallics also increased during the year as reflected in the 3.0% increase in the overall nonmetallic index. Gypsum products showed the largest gain in this group with a 7.4% increase. Only three nonmetallic commodity price indexes declined, and two remained unchanged. Fertilizer materials declined 2.0%, phosphates declined 4.7%, and domestic muriate of potash declined 0.1%. Phosphate and total potash remained unchanged. Prices for fuels, related products and power increased 3.9% in 1972. Price indexes for anthracite and bituminous coal increased 4.2% and 6.8%, respectively. Coke increased 4.6%, gas fuel prices increased 5.6%, electric power increased 7.0%, and crude petroleum, and petroleum products increased 0.5% and 2.0%, respectively.

During 1972, mineral energy resource prices were generally up for coal and natural gas and, down for petroleum and petroleum products. Bituminous coal increased more than 15%; anthracite prices increased at rates of almost 3% to more than 5%. Prices of petroleum and petroleum products declined with the exception of crude petroleum which was unchanged at $3.39 per barrel and the price of No. 2 distillate fuel oil for all Gulf ports. Gasoline prices declined over 2%. The average price of natural gas at the wellhead increased over 2% from 18.2 cents to 18.6 cents per thousand cubic feet.

The average cost of electrical energy in the United States in 1971 (latest data available) rose 0.1 cent above that of 1970, to 1.7 cents per kilowatt hour. The average cost of electrical energy in both the residential market and the commercial and industrial markets showed a 0.1-cent increase to 2.2 and 1.4 cents per kilowatt hour, respectively. Costs in all geographic areas with two exceptions either remained unchanged or increased only 0.1 cent per kilowatt hour. The two exceptions were the East South-Central region and the Middle Atlantic region in which the price increased 0.2 and 0.3 cents per kilowatt hour, respectively. Alaska and Hawaii remained the highest cost areas, and the East South-Central region remained the lowest cost area.

Principal Metal Mining Expenses.—The index of principal metal mining expenses (1967=100) continued to climb in 1972, although not so fast as in 1971. Electrical energy reflected the largest increase, 7.0%. The labor component was next, rising 5.9%. Fuels increased 3.9%, compared with 7.8% for the previous year. Of the principal metal mining expenses, the index for supplies again increased at the slowest rate, 3.8%. Overall, the index climbed 5.1%.

Costs.—The 1972 index of relative labor costs and productivity for iron ore showed an increase in productivity; that for copper ore showed a decrease in productivity. The index of labor costs per unit of output for iron ore mining decreased 2.2%; the figure for copper ore mining increased 15.0%. The index of value of product per man-period was up 11.6% for iron ore mining; the figure for copper ore mining declined 5.0%. The index of labor costs per dollar of product for mining iron ore and copper ore declined 3.7% and increased 16.9%, respectively. The index of relative labor costs and productivity for bituminous coal in 1971 (latest data available) showed a 15.1% increase in labor costs per unit of output, an 8.0% increase in the value of product per man-period, and an 8.0% increase in labor costs per dollar of product. The index for petroleum for 1970 (latest data available) showed a 1.5% increase in labor costs per unit of output, an 8.8% increase in the value of product per man-period, and a 0.7% decrease in labor costs per dollar of product.

The range of changes in all but two of the price indexes for mining construction and material handling machinery and equipment during 1972 was between plus 2.8% and plus 4.1%. The exceptions were portable air compressors which decreased 1.9%, and power cranes, drag lines, shovels, etc., which increased 4.5%.

INCOME AND INVESTMENT

National Income Generated.—In 1972 national income originating in all industries was $942 billion, a 9.6% increase over 1971. The mining industries advanced

17.6%, a sharp contrast to last year's 8.6% decline. Crude petroleum and natural gas again increased in 1972, by 27.5%, which was by far the largest increase in any sector. Coal mining increased to $2.4 billion, a 15.7% gain. The mining and quarrying of nonmetallic minerals and metal mining advanced 9.7% and 6.7%, respectively, over 1971. Mineral manufacturing also increased in 1972, to $252 billion, an 11.6% increase. The primary metal industries and the manufacturing of stone, clay, and glass products increased about 13%. Petroleum refining and related industries showed a gain of 9.1%, which was slightly higher than that of 1971.

Profits and Dividends.—In 1972 the average annual profit rate on shareholders' equity in manufacturing industries increased for the second consecutive year. The increase was 9.3%, more than twice the 4.3% increase in 1971. Profit rates for almost all the selected mineral manufacturing corporations posted increases with the exception of the petroleum refining industries. The greatest percentage increase was a 35.6% increase to a rate of 6.1 for primary iron and steel. Primary nonferrous metals increased 15.7% to a rate of 5.9, which was still the lowest annual profit rate among the selected mineral manufacturing corporations. Chemicals and allied products increased 9.3% to a rate of 12.9, which was the highest among the selected corporations. Petroleum refining declined 16.5%, although it paid out the highest level of dividends, $3.3 billion, an increase of 1.8% over that of 1971. The sharpest decline in total dividends was reflected by primary nonferrous metals, a 27.2% decrease from the previous year, followed by primary metals with 13.9%. Stone, clay and glass products reached $415 million in 1972, a 15.9% increase. Primary iron and steel registered a 0.2% increase, a sharp contrast to last year's 21.3% decrease. The total dividends for all manufacturing in 1972 reached $16.1 billion, a 5.8% increase over that of 1971.

The total number of industrial and commercial failures in 1972 declined to 9,566, the lowest figure reported since 1969. This represented a 7.4% decrease, while the current liabilities increased 4.3%, surpassing the $2 billion mark. There were 44 mining failures reported in 1972, compared with 38 in the previous year, but the current liabilities declined by more than $3.5 million. In the manufacturing sector the number of failures declined over 19%, and the current liabilities increased 8.3% over that of 1971.

New Plant and Equipment.—In 1972 new plant and equipment expenditures by mining firms continued to rise, reaching $2.42 billion, a 12% increase over that of 1971. The manufacturing sector, which experienced a decrease last year, came back up to over $31 billion. Among selected mineral manufacturing industries, the expenditures were mixed. The most significant change occurred in stone, clay, and glass products, which increased over 41%. Primary nonferrous metals also increased, from $1.08 billion in 1971 to $1.18 billion in 1972, a 9% gain. Primary iron and steel, and petroleum and coal products registered 10% decreases for 1972.

Plant and equipment expenditures of foreign affiliates of U.S. companies in mining and smelting decreased in 1972 to $1,657 million, a 4% decrease from 1971. The only increase in expenditures was posted by Europe, which gained $2 million over the previous year. Canadian expenditures declined 7%, a sharp contrast to last year's large increase. Latin American expenditures declined 6% to $230 million. The petroleum outlay in 1972 went up again, this year by 10% in comparison with last year's figure of 25%. All reporting areas showed gains in petroleum expenditures except for Latin America. The manufacturing sector rose 13% to 7.6 billion, with Canada the only area to show a decrease.

Issues of Mining Securities.—In 1972, estimated gross proceeds of new securities offered by extractive industries totaled $2,010 million, compared with $1,283 million in 1971. Common stock accounted for 64.7% of the proceeds, substantially less than 1971. The remainder was absorbed by bonds, 35.1%, and preferred stock, 0.2%.

Foreign Investment.—The value of U.S. direct investments abroad for all industries increased 10% to $86.0 billion in 1971 (latest data available). Investments in developed countries, which accounted for 68% of the total, also increased about 10% during the year to $58 billion. Investments in petroleum affiliates accounted for 28%

of the 1971 total. Petroleum investments increased 11.7% in 1971, the rate of increase being about the same in both developed and developing countries. Developed countries accounted for 53% of the investments in petroleum affiliates. In 1971 the book value of Canadian petroleum affiliates gained $327 million. The value of petroleum investments in European affiliates increased $736 million. Investments increased for all developing countries. The other Asia and Pacific section increased almost 36%, the Latin American section increased 6.5%, the other Africa section increased 9.5%, and the Middle East increased only 1.6%.

U.S. direct investments in foreign mining increased $583 million to $6.72 billion during 1971 (latest data available). Net capital outflows increased to $519 million, and reinvested earnings declined. The developed countries accounted for more than 60% of the U.S. direct investments.

The total value of foreign direct investments in the U.S. was $13.7 billion in 1971 (latest data available). Almost 23% of this or $3.1 billion was invested in petroleum. Petroleum gained 4% for the year, much less than the 20% gain the previous year. European firms provided 92% of the petroleum investments; firms in the United Kingdom and the Netherlands alone accounted for 84%.

TRANSPORTATION

The total quantity of selected minerals and mineral energy products transported by railroad and water in the United States declined in 1971 (latest data available), with transportation of mineral products declining at a greater rate than the total for all commodities. Rail transportation of total mineral products declined 8.8%, but water transportation remained steady. Almost 63% of selected metals and minerals, except fuels, was transported by rail, and more than 59% of selected mineral energy resources and related products was transported by water. Total selected minerals and mineral energy products accounted for 57.3% of all commodities transported by rail and 84.3% of all commodities transported by water.

In the metals and minerals except fuels category, the quantity transported by rail decreased 7.3% to 400.9 million short tons. Iron ore and concentrates, crushed and broken stone, sand and gravel, and phosphate rock were the largest users of rail transport in volume terms. Rail transport for most minerals declined in 1971, with the notable exception of slag, which increased 48%; gypsum and plaster rock which increased more than 17%; and phosphate rock, which increased more than 4%. Leading the decline were pig iron, which declined over 23%; other nonferrous ores and concentrates, almost 19%; and iron and steel primary products, over 13%.

In the same category transportation by water decreased in quantity by 0.2% to 239.7 million short tons. Iron ore and concentrates and crushed and broken stone combined with sand and gravel continued to be the largest commodities by volume.

Mineral energy resources transported by rail in 1971 amounted to 396 million short tons, a decline of 10.2% from that of last year. Shipments of bituminous coal and lignite accounted for more than 89% of selected mineral energy resources and related products transported by rail.

Coal and crude petroleum accounted for more than 45% of the tonnage of mineral energy resources transported by water. Large amounts of gasoline and distillate and residual fuel oil were transported by water in 1971. The total volume of selected mineral energy resources and related products transported by water was 558 million short tons, which was very similar to that of 1970.

A total of 935,000 miles of gas pipeline existed in 1971 (latest data available), a 2.2% increase above that of 1970. Total petroleum pipeline mileage in 1971 increased to 219,000 miles. The total petroleum pipeline mileage reported was distributed among the following: crude gathering systems in field operations, 33%; larger size crude trunklines, 34%; and petroleum product pipelines that extend from refineries to extraction terminals, 33%.

RESEARCH ACTIVITIES

National expenditures for research and development activities for all industries in 1971 (latest data available) totaled $18.4 billion, almost a 3% gain over the 1970 expenditure of $17.9 billion. In 1971 company expenditures accounted for $10.7 billion, and the Government funded $7.7 billion; the figures for 1970 were $10.1 billion and $7.8 billion, respectively. Research and development expenditures in petroleum refining and extractive totaled $505 million in 1971, a 16.9% decline from the 1970 figure of $608 million. Almost 97% of the 1971 figure and 93% of the 1970 figure were financed by private expenditures; Government funds supplied the remainder. Research and development expenditures in the chemical and allied products industries were $1.8 billion, very close to the 1970 figure, which was almost 5% greater than the 1969 figure. Company expenditures made up nearly 90% of the total in both 1970 and 1971.

Bureau of Mines.—Bureau research activities continued to be directed toward efficient use of our natural mineral and fuel resources to insure adequate mineral supplies without objectionable environmental, social, and occupational effects. Bureau research programs were divided into the following groups in 1972: mining research, metallurgy research, resource recovery and pollution abatement, coal research, petroleum research, oil shale research, health and safety research, and explosives and explosions research. Economic research was directed toward the same ends as other Bureau of Mines research; it included environmental problems and studies of supply and demand problems.

Bureau of Mines funding of obligations for mining and mineral research and development was $70.9 million during fiscal year 1972, a 17.6% increase above fiscal year 1971. Funds for applied research increased to $32.8 million, 46% of the total. Funds for basic research rose to $7.8 million, 11% of the total, and funds for development increased 40% to $30.2 million, which is 43% of the total. Obligations for fiscal year 1973 are estimated to increase by more than 10% to $78.4 million. Most of this increase is estimated to be funds for development; funds for basic research are estimated to decline. Bureau of Mines funding obligations for total research were $40.6 million in 1972, a 4.7% increase. Funds for engineering sciences were $28.7 million; for physical sciences, $10.5 million; for mathematical sciences, $0.5 million; and for environmental sciences, $0.9 million. The estimated figures for 1973 are very close to the 1972 figures. Highlights of the accomplishments of Bureau research programs, including work in progress, are as follows:

Mining.—Ore recovery ratio is a primary indication of the efficient extraction of our natural resources. As the size of pillars left by mining is decreased, the ore recovery ratio increases. In situ stress measurements and triaxial strength tests on model pillars containing planes of weakness showed conclusively that the in situ strength of full-size mine pillars containing planes of weakness can be predicted with good accuracy. With this information, stable pillars can be designed using safety factors as low as 1.5, a significant improvement over the value of four that is generally used in the design of rock structures. Use of these techniques to predict pillar strength will permit use of the lower safety factor in design and could increase productivity without sacrificing safety.

Other advances in understanding pillar behavior were made as a result of stiff loading tests on model pillars. In the case of a partially failed pillar, it was shown that the decrease of load results mainly from a decrease in the effective cross sectional area of the pillar and that the maximum stress on the undisturbed section remains a constant. This maximum stress can be estimated from the prefailure load-deformation curve. Also confirmed was that the addition of as little as 1 to 4 pounds per square inch radial confining pressure can increase the post-failure strength of pillars by as much as 10%.

Several major improvements were made in in situ stress determination techniques. Accurate stress measurements can now be made in high stress areas where discing occurs by means of a special type of borehole deformation gage that requires only one-half of an inch of overcoring. The necessary corrections have been determined by finite element analysis and proven correct by field tests. An improved type of borehole gage also has been developed which eliminates the drift problem. This gage is sufficiently stable so that it can be used to measure change in stress with time.

A field technique was developed and tested for locating hidden faults that cause serious ground support and hydrologic problems in certain uranium deposits in Wyoming. In another study theoretical analysis has shown that a 2-foot thick layer of sand around an 8-foot diameter corrugated aluminum culvert can reduce the maximum stress by a factor of 10.

Tests on small reinforced polymer-impregnated concrete beams for use as mine supports showed that conventional design concepts might create a condition where reinforced polymer-impregnated beams fail violently. This problem can be solved by the addition of small quantities of steel fibers.

As the first step toward developing a new mining method for the native copper ores of the upper Michigan peninsula, a 5½-month test demonstrated that electronic sorting of coarse ores is feasible. In another research effort on native copper ores, it was found that high-frequency induction heating does not produce the thermal shock necessary for the fragmentation of these ores. However, a combined thermal-hydraulic rock fragmentation technique was successfully tested on other rock types.

Hydraulic pipeline transportation tests to study the effect of particle size on head loss produced surprising results. At high velocities, six sizes of glass heads showed no discernable differences in head loss and all head losses approached clear water behavior as velocity increased. At lower speeds, below 7.5 feet per second, head loss becomes an inverse function of particle size; that is, an increase in particle size resulted in a decrease in head loss, indicating that less energy was dissipated in particle interaction as particle size increased. This is in contradiction to the widely accepted Durand equation, which states that head loss is directly proportional to particle size.

Digging and loading tests on bulk material developed quantitative evidence that approximately four times as much energy is required for the loading process. Thus, any improvement in the initial penetration process could result in considerable saving in both design and operating horsepower.

Metallurgy.—The general objective of the metallurgy program of the Bureau of Mines is to provide, through research and development, the scientific and technical information necessary to encourage and stimulate the nonfuel minerals industry to make advancements in technology. Industry's response and acceptance of Bureau technology was indicated by the construction of a new plant in Mississippi, modeled on the Bureau-developed method for producing electrolytic chromium. It is the only commercial process in use in the United States for producing the metal. The Bureau-developed ion exchange process for recovering uranium values from mine waters, when tested on a semiindustrial scale, was accepted by several commercial uranium producers. In another development, the Bureau's modern version of the carbon-in-pulp gold recovery process was pilot tested in a cooperative effort and then adopted by the Homestake Mining Co. at Lead, S. Dak., where it was shown that gold could be recovered effectively from slimes. As a result of the successful pilot plant investigations, the company has built a new 2,350-ton-per-day carbon-in-pulp plant to replace its old slime plant. Another gold process developed by the Bureau has achieved acceptance for the recovery of gold from domestic deposits at Carlin and Cortez, Nev., where leaching techniques have been successfully applied to submarginal gold ores.

The development of a process to beneficiate nonmagnetic taconites into a commercially acceptable iron ore was also accomplished by Bureau researchers. Although magnetic taconites have been used increasingly as a source of domestic iron ore, large reserves of nonmagnetic taconites have been bypassed for lack of an acceptable beneficiation process. The Bureau conducted a vigorous program on laboratory and pilot plant scale for flotation of nonmagnetic taconites. The results led to a patented method to improve the grade of the ore from 30% iron to over 65% iron in concentrates meeting commercial acceptance. In 1972, after several years of cooperative effort with the Bureau, the Cleveland Cliffs Iron Co. announced plans to allocate $190 million for its Tilden project, which would have an initial annual output of 4 million tons of pellets using the Bureau-developed selective flocculation flotation process on Marquette Range nonmagnetic taconites. This plant will be the first of its kind to process low-grade, fine-grained, nonmagnetic taconite.

Research is underway on the development of a new process to recover phosphate while eliminating the slime storage ponds—the major problem in the current extraction technique. Slimes are stored in huge ponds, covering thousands of acres, which precludes the use of this valuable land for other purposes. Another problem is that waste slimes contain more than 20% of the phosphate mined. The Bureau has recently found that direct acidulation of land pebble phosphate ore with sulfuric acid in a continuous miniplant recovered approximately 95% of the phosphate while forming a sandy solid residue which should cause no waste disposal problem. The new process appeared to be technologically feasible, but additional research is necessary to establish the economic and environmental feasibility.

Bureau of Mines research on copper is concerned with extracting the metal from low-grade ore and the development of roast-leach methods for processing concentrates. In one study, a process has been developed to recover copper more effectively from the run-of-mine material deposited in dump piles or heaps. In another study. laboratory research has shown that roasting copper sulfide concentrates (chalcopyrite) with lime followed by acid leaching is effective for obtaining high copper recovery and at the same time eliminating the generation of sulfur dioxide, a serious air pollution problem in conventional roasting and smelting operations. Because the roast is autogenous, considerable gangue can be tolerated in the concentrate. This feature would reduce flotation costs and also save valuable byproduct minerals, such as molybdenite, that are only partially recovered in the present techniques for producing clean concentrate for smelter feed.

In other copper research, a simple and inexpensive sulfatizing roast-leach procedure has been developed for treating copper concentrate from sulfide ores. Roasting the copper concentrate with iron oxide converts essentially all of the contained copper to a water soluble copper sulfate. Gold and silver present in the leach residue are amenable to subsequent recovery. It may be possible for the copper to be recovered by electrowinning or, alternatively, copper can be concentrated readily by solvent extraction. This procedure is environmentally attractive since it concentrates the SO_2, which facilitates the conversion to acid.

The Bureau's materials research effort included studies on ceramics, catalysis, and the rolling and forging of ductile iron. The hot working of ductile iron promises major advantages. First, ductile iron, made primarily from scrap in relatively simple equipment, does not require the degree of refining necessary in steel production. The second advantage is that forgings could be produced from simple shapes cast to near final dimensions. The Bureau's experimental rolling and forging tests have shown that certain ductile iron alloys can be successfully hot worked to obtain final shapes, with properties adequate for many applications where steel is now used. Research is continuing to determine the best conditions under which ductile iron can be worked, including the effects of starting materials and compositions.

Ceramic and nonmetallic minerals research in the Bureau was directed toward increasing the availability of such products as replacements for metals and as a means of improving the efficiency of minerals and metals processing. The Bureau began a new research program on more effective methods to process, fabricate, and utilize nonmetallic minerals and materials. Research under this program included testing clays and a variety of ceramic materials in applications that will expand the use of these resources, developing drilling fluids and modified portland cements for use in high-temperature and high-pressure drill hole applications such as are encountered in very deep oil wells, and creating new uses for low-cost sulfur and waste sulfate products. The work on testing and evaluation of ceramic raw materials was designed to provide technical assistance to State geologists.

Resource Recovery and Pollution Abatement.—The metallurgy research program also included a wide variety of projects on secondary materials recovery and pollution abatement studies on mineral processing wastes, which are described in the Bureau's Information Circular 8595.

Bureau of Mines research has resulted in the development of an effective and technologically feasible process for the desulfurization of stack gases. The relatively straight-forward method, known as the "citrate process," was originally designed to remove sulfur dioxide from the stack gases of smelters treating sulfide ores. The process is now being evaluated for controlling emissions from fossil fuel fired powerplants, chemical processing plants, and oil refining operations.

The Bureau is currently constructing a pilot plant at Kellogg, Idaho, which will treat stack gas from the lead smelter operated by the Bunker Hill Company. The plant will process about 1,000 cubic feet per minute of gas containing 0.5% sulfur dioxide. Sulfur dioxide removal is expected to be over 98%.

An independent pilot plant test of the citrate process also is underway as a joint effort of Pfizer Inc., Arthur G. McKee and Co., and Peabody Engineering.

Control regulations for sulfur dioxide air pollution are expected to create an abundant supply of low-cost sulfur and sulfuric acid. The Bureau has initiated a program to develop new uses for sulfur and has expanded its research efforts to utilize sulfuric acid in mineral and metal processing schemes. The current research included studies on sulfur-asphalt mixtures for paving materials; sulfur formulations for stabilizing minerals tailings piles; construction materials modified with sulfur; a new approach to phosphate production where the total ore is acidulated, thus avoiding the slimes disposal problem; and sulfuric acid leaching of limey copper ores, which cannot be beneficiated by conventional methods.

The Bureau's process for recovery of the metal and mineral content of municipal incinerator residues has received national attention which culminated in the Environmental Protection Agency awarding a $2.4 million grant to the City of Lowell, Mass., to build a 250-ton-per-day demonstration plant. The semicommercial installation will be the first of its kind in the world and will recover the ferrous, nonferrous, and glass components from several municipal incinerators in the Lowell area.

In another related approach to the urban refuse problem, a raw refuse resource recovery pilot plant was placed onstream. The new pilot plant, which has a capacity of 5 tons per hour, accepts refuse directly from municipal collection vehicles. The refuse is broken down into its metal, mineral, and energy fractions by a series of shredding, air classification, magnetic separation, and screening operations. In addition to the metal and mineral values, there is recovered a combined paper and plastic fraction which has a fuel value of over 8,000 Btu per pound.

Research is nearing completion on the combined railroad car-junk auto incinerator, which is being conducted in cooperation with a scrap processor. The incinerator allows smokeless burning of 20 scrap cars or one railroad car per hour.

Three additional smokeless scrap automobile incinerators patterned after the Bureau's prototype have been constructed, bringing to 20 the number of commercial installations. Commercial air and water elutriators, based on the Bureau's research on recovery of nonferrous metals from junk car shredder rejects, have been or are being constructed at a number of scrap yards. A cryogenic process for recovery of copper from scrap wire is also being adopted by private companies as a result of Bureau research. In cooperation with the Ford Motor Co., a process for recovery and recycle of waste polyurethane foam from scrapped automobiles has been developed.

Bureau-developed methods for stabilization of mine and mill wastes continued to be adopted by industry. A large copper company has utilized one of the Bureau's techniques to stabilize 120 acres of copper mill tailings in Nevada. During the past year the Bureau has cooperated with the Forest Service, a number of State agencies, and the private sector in developing methods for overcoming air and water pollution resulting from mineral tailings disposal in Arizona, Colorado, Michigan, Idaho, Missouri, and Washington. In a cooperative cost-sharing effort with the Florida phosphate industry, a substantial research program has been initiated to develop a practical method to dewater phosphate slimes. The study involved both basic laboratory studies and large scale field tests on the more promising dewatering schemes. Methods to dewater and dispose of a number of other mineral processing wastes such as red muds and taconite tailings were also being investigated.

Other projects related to secondary materials recovery included a variety of studies on techniques to recover and recycle values from sludges, drosses, dusts, and waste mineral processing waters. A major effort was also being made to decontaminate waste processing waters for recycle and reuse.

Coal.—Major emphasis in coal research again was placed on the production of clean-burning fuels from coal to help meet the Nation's rapidly increasing need for energy, while at the same time maintaining or improving the quality of the environment.

On the basis of a 2-year detailed study, the National Academy of Engineering's Committee on Air Quality Management Ad Hoc Panel on Evaluation of Coal Gasification Technology concluded that pilot plant work on the Bureau's SYNTHANE Process should be expedited as one of the four most important American processes for converting coal to substitute natural gas (SNG). In addition, the Academy's ad hoc panel found that the Bureau's HYDRANE hydrogasification process for SNG showed great promise and recommended further development.

During the year bituminous coal was successfully processed in the Bureau's 10-pound-per-hour HYDRANE unit. In these tests it was confirmed that strongly caking coal could be processed without first treating the coal to destroy its caking characteristics. Because up to 95% of the methane produced comes from the direct reaction of hydrogen with coal, this process offers further economic advantage over other coal gasification schemes in that a minimum amount of methanation is required to convert the gases from the gasifier to pipeline quality gas.

In other coal gasification research, strongly caking coal from the Upper Freeport seam in Preston County, W. Va., was gasified in a stirred-bed pressurized producer at 125 pounds per square inch, gage, and a side stream of the gas was processed to remove up to 98% of the H_2S. This latter step was accomplished by means of a solid absorbent consisting of 25% iron oxide and 75% fly ash.

During the year, the Bureau initiated a pilot field experiment to establish the feasibility of gasifying Western subbituminous coals in situ. Underground coal gasification could provide a major source of clean energy that would significantly reduce or eliminate many of the problems associated with conventional underground mining.

Experiments were successfully concluded in a small laboratory process development unit after showing that coal containing nearly 5% sulfur and 16% ash could be liquefied with hydrogen to yield a premium fuel oil essentially ash free and containing only 0.2% sulfur. A larger diameter reactor was constructed to study flow problems that may be encountered in a scale-up of the process.

In related research, conditions (4,000 pounds per square inch, gage, at 400°C and 2 hours residence time) were established for optimum yield of oil produced by reaction of CO and H_2O with North Dakota lignite in the absence of catalyst. Yield was found to be high at 3.2 barrels of oil per ton moisture- and ash-free lignite, or 63 weight percent, with 73 weight percent conversion of the feed.

During the year construction was undertaken on a three-stage high-temperature coal combustion pilot plant designed to produce a low-ash, high-temperature gas suitable for open-cycle MHD power generation. Research on mine waste land reclamation emphasized work on bituminous spoil and anthracite refuse banks. Bureau personnel cooperated in a pilot plant SO_2 removal study conducted at a midwestern power and light company.

Petroleum.—Laboratory-induced hydraulic fracture tests were conducted on oriented sandstone specimens whose tensile strength and permeability had been measured. Breakdown pressure and fracture orientation were determined as a function of several levels of stress, load saturation, and rate. The objective was to determine if horizontal compressive stress is always the primary factor controlling fracture orientation or if the directional properties of the rock matrix influence the induced fracture direction at low stress levels and/or low load rates.

A triaxial load cell and a closed-loop, automatic pressurization system were developed to test the specimens. Preliminary analysis has indicated that fracture orientation cannot be reliably predicted whenever the stress difference in horizontal components is less than 200 pounds per square inch. In this situation, the induced fracture direction is usually governed by permeability.

Oil and gas reservoir properties must be known to develop more efficient and economical oil and gas extraction methods. Mobility, a measure of the capacity of a reservoir rock to conduct a fluid, varies with pressure, fluid volume, liquid-gas ratio, and gas velocity. The Darcy equation is inadequate for calculating the pressure gradient needed to recover gas-condensate fluid from a reservoir at an economic rate. Suitable equations have been developed so that mobility can be computed more reliably.

The application of radiotracer pulses to the evaluation of the fracture systems of underground formations was tested in the field and in an oil shale retort having a known void matrix. Best results were achieved when the tracer was added to the flowing gas stream and sampled as near to the formation face as possible. When the pulse emerges at the production well, it has been modified by dispersion through the fracture system. The degree and rate of dispersion are used to evaluate the reservoir fracture and void systems. Nonradioactive gas tracers can be used where the presence of radioactivity might be objectionable.

Research continued on the correlation of crude oil properties. The purpose of the study is to identify the source of marine oil spills when the source is otherwsie not known. A study of the potential use of knowledge of the orientation of natural fractures in a gas storage reservoir in Eastern Ohio was completed as part of a cooperative research effort with the American Gas Association.

Numerical model studies indicated that fracture placement is important in gas-storage operations and that the composite model simultaneously determines reservoir and fracture pressure distribution. A basic two-dimensional dry-gas reservoir simulator was developed using the alternating-direction-implicit procedure. Using a relationship developed from Darcy's law to calculate the withdrawal rate of gas from any reservoir node penetrated by a fracture, the 2-D model was modified to provide the capability of simulating ideal fractures of any length and with orientation parallel to either of the finite-difference grid lines. This modified 2-D model was used to investigate the withdrawal capacity of various fracture patterns in a square reservoir. The results indicate that well and fracture placement are important in the development of a gas-storage field in which the withdrawal capacity over short periods of time is to be optimized.

An updated analysis of production tests from Project Gasbuggy over a 3-year period indicated that the flow-rate capacity of a gas well after stimulation by a nuclear explosion will be four to six times greater than if the same well were stimulated by conventional fracturing. Previous testing over a 1-year period indicated a six- to seven-fold increase in production. It is essential that the thickness-permeability product for the unaltered formation be substantial for a nuclear-stimulated method to be successful. Formation fracturing resulting from detonation of a nuclear device extends out into the formation only about 300 feet, depending on the size of the charge. Production tests and analyses for Project Rulison are being continued.

Fuels combustion research was oriented principally toward more explicitly defining the influences that fuel composition, engine adjustments, and engine-accessory devices have on pollutant emissions and on fuel economy.

Confirming evidence obtained in prior years, gasoline composition was again shown to have a significant bearing upon the photochemical reactivity of its combustion products. The light aromatics, benzene and toluene, produced relatively nonreactive products; xylenes and heavier aromatics produced moderate to highly reactive products. Highly branched alkylates were also identified as a prominent source of photochemically reactive exhaust. The principal significance of the findings was to show that there is a complex relationship between fuel composition and pollution effects, and that detailed knowledge of fuel composition is required and must be used for reliable prediction of the pollution effect.

Automobiles and truck engines equipped with emission-control devices designed toward meeting stringent pollution-control requirements were tested. Results show that emissions are markedly reduced but the requirements now projected for the mid-1970's can be met only with heavy penalties to performance and fuel economy. Because trends appear to impact adversely on energy consumption, the work in this area was redirected to emphasize improvement of fuel economy in the low-emission systems.

Gas mixtures simulating gas made from coal were found to have combustion characteristics favorable for the use of such fuel in high-efficiency engines.

Research on the toxicity hazard from diesel engines operated in underground mines was continued. Carbon monoxide and oxides of nitrogen, which present the principal toxicity problem, were found controllable at levels easily compatible with the ventilation requirements for carbon dioxide. This represents the minimum ventilation requirement possible if fuel is burned underground and combustion products are discharged into the underground environment. Significant progress was made toward the development of an adequate monitoring warning system against excessive accumulation of toxic exhaust products.

A demonstration of plugging and safe mining through an oil well penetrating the Pittsburgh coalbed in northern West Virginia was successfully accomplished. Expandable cement and a fly ash-gel-water slurry were utilized to seal the well, above and below the coalbed.

Oil Shale.—The Bureau continued its core assay program in connection with the Department's proposed oil shale leasing program. Also, samples from two cores analyzed for dawsonite content, using X-ray diffraction, expanded the knowledge of extent of deposition of this mineral. Dawsonite, of potential significance as a source of both sodium and aluminum compounds, occurs in intimate association with oil shales in the deeper deposits of the Piceance Creek Basin in Colorado. However, the extent of the mineral deposit is poorly defined. Although one core was from what is believed to be near the outer edge of the deposit, it contained a continuous dawsonite-bearing section 169 feet long. The second core, taken 6 miles west of the first, had a 680-foot continuous dawsonite section plus several shorter sections. Improved definition of these mineral deposits could have an important bearing on oil shale development and mining plans because of the potential byproduct credits.

A hydrogenated naphtha with sulfur content of less than 0.001% and nitrogen content of only seven parts per million was produced by a combination of once-through hydrocracking of crude shale oil and once-through hydrofining of the hydro-cracked naphtha. A series of catalytic reforming runs was made to evaluate this clean naphtha as a feedstock. In one such test, an 89-octane number reformate was produced from 40-octane feed with a yield of 80% by volume. This octane number of 89 is sufficiently high that the unleaded gasoline could presumably be used in a refinery pool.

Mild oxidation was shown to have potential as an economic method of preparing low-pollution shale oil fuels. In one experiment, such treatment removed about one-half of the nitrogen from naphtha.

Two new research scale oil shale retorts were placed in operation. In one, gallon-size samples of crude shale oil were prepared under closely controlled conditions to provide retort engineers with required kinetic and mechanistic data. The second was a one-half-ton retort. In the first run of this retort, a 500-pound block of shale retorted satisfactorily, reaching a maximum internal temperature of 1,090°F after 18 hours, while a bed of smaller-sized shale surrounding the block reached 1,650°F. This retort, which permits both visual and instrumental observation of the retorting shale, will provide better understanding of the environmentally-attractive in situ method of processing that is being developed.

Bureau researchers successfully used electrical resistivity surveys in the Wyoming field test area to detect two shale rubble areas that had been created underground by chemical explosives. The data were used to make estimates of the shape, height, and diameter of the two rubble zones.

Economic Analysis.—The economic research program within the Bureau of Mines continued the study of economic factors within the mineral industries as well as how the mineral industries are affected by the national economy. The purpose of this research was to provide decisionmakers with accurate information and up-to-date analyses of current conditions, to aid in making their decisions. The economic analysis program attempted to produce general methodology needed for such analysis as well as information relevant to problem solving in the field of mineral economics. Major long-term research projects undertaken included the study and forecasting of demand, supply, and productivity; financial analysis; the economics of waste recycling; input-output analysis; and the study and report of weekly price changes. Many short term economic projects were also undertaken to answer immediate questions.

Health and Safety.—A major advance in the ground control program occurred with the successful underground installation of a pumpable roof bolt, which was found to have anchorage capability exceeding that of conventional expansion-shell roof bolts. Estimated costs of installed liquid bolts compared favorably with those for conventional bolting.

A self-advancing roof shield, developed under contract and designed to protect miners in the working face area, has been delivered to the Bureau and demonstrated at the Bureau's Bruceton mine.

Water infusion tests in the Pittsburgh coalbed have shown that the techniques developed by the Bureau are effective in reducing methane emission in the face area by 50% to 80%. A semirigid, hose-type infusion packer with appropriate fittings was designed, developed, produced, and tested under a research contract.

In another contract effort, commercially available borehole packers for sealing horizontal holes in coalbeds were evaluated, and a high-pressure packer was developed that is less costly to produce and can be easily and economically repaired in the field. This is an improved tool for research on and application of techniques for methane control. An analysis of data on methane emissions from underground bituminous coal mines was undertaken. The correlations obtained to date can be used to predict the methane emission rate and assist in planning methane control procedures in bituminous coal mines.

A new generation of emergency mine communications was developed offering greater range, coverage and reliability. The system permits voice communication from the mine surface through the rail haulage carrier current trolley system and up to 500 lateral feet from the carrier system to a roving miner with a wireless personal pager. Alternate systems provide two-way voice communication between the mine surface and mining machine operators through the mine telephone system and mining equipment trailing cables and alternative communication paths through borehole power-line cables and through-the-air transmission to mine surface communications equipment. These developments will provide voice communication with all underground operating crews immediately after a disaster, permitting instructions about escape routes to be given to the miners and increasing the probability of survival and rescue.

An unmanned vehicle and three borehole devices were developed for probing mine openings during post disaster and rescue operations. A probe drill guidance system has been developed to reduce probe hole drilling time. The system will enable a drill operator to survey the bottom of the hole, calculate hole coordinates with an onsite computer, and alter the course of the drill bit, if necessary, without removing or disconnecting the drill string. The system consists of magnetic and gravity sensors, wireless data telemetry, and a remote-controlled directional drill.

A portable area lighting system and a machine-mounted lighting system utilizing circularly polarized high-pressure sodium lamps were designed and delivered under a contract to explore and develop new concepts for illumination of underground coal mines.

An underground demonstration of respirable dust suppression showed that significantly lower respirable dust levels can be maintained using a foam system as opposed to water sprays or ventilation alone. A research and development contract has resulted in the delivery of two prototype mine dust meters that provide real-time instant indication of respirable and float dust concentrations in the mine environment.

A prototype noise control system developed for a percussive drill was free from muffler icing problems and reduced the sound level from 115 to 101 decibels, permitting longer working time in the area. Prototypes of the discriminating ear protective device, which permits the wearer to hear low-level warning signals but still provides protection from sounds in excess of 90 decibels, were fabricated, tested, and found generally satisfactory.

Research and development on engine emission control of diesel-powered equipment underground had indicated that neither a water scrubber nor an oxidation catalyst has any significant effect on oxides of nitrogen emissions. The use of exhaust gas recirculation reduced NO_x, while oxidation catalysts reduced carbon monoxide levels. Continuing efforts on developing a satisfactory monitor for CO_2, CO, and NO_x have uncovered some problems in vibration stability during prolonged engine operation.

A prototype infrared methane detector was developed that can be packaged into a machine-mounted methane monitor with greater reliability than is possible with existing devices. Continued work on a nuclear technique coal dust incombustibles content analyzer has developed advanced prototype designs of both cup and in situ types of devices.

A portable device was developed for use in the field to determine whether permissible blasting machines are in operating condition. The Bureau developed a new, relatively inexpensive, and easily installed device called the horizontal roof strain indicator. Preliminary test results have indicated that 1/1000 inch per inch horizontal strain occurring within 2 days after bolt installation indicates an unstable roof condition. In other research directed at the identification of potential roof falls, it has been shown that the first major parting in a mine roof can be detected, the distance to the parting measured, and the inclination of the parting plane determined by means of sonic testing the roof with pulsed shear waves. Efforts were continuing to adapt the miscroseismic techniques, developed for detecting rock bursts in deep metal mines, for use in coal mines to prevent mining machinery noises from interfering with the detection of rock noises so that microseismic techniques can now be employed during normal mining operations. Under contract, a simple borehole device to determine the modulus of rigidity of coal-measure rocks has been developed and delivered to the Bureau. The physical properties determined by use of this device are essential to the development of rational methods of designing mine pillars and other underground structures. An evaluation into the feasibility of using isolated electrical supply systems in underground coal mines confirms that it is possible in principal to reduce fault trip currents to a level to assure personnel protection, provided that problems involving circuit breakers can be handled. A contract studying the feasibility of remote control systems and the development of remote control sensors and devices has successfully developed a laser guidance system for use in alignment of continuous miner operations as well as a shuttle car guidance system with obstruction detection capabilities. In a contract on inherently safe mining systems, nonfatal accident data were obtained and correlated with fatality data to precisely define the hazards that exist in the working sections of continuous and conventional mines. All major mining equipment manufacturers were contacted and details on the characteristics and number of units in the field were obtained. Conceptual design modifications for all equipment used in the working sections were prepared, evaluated and agreed upon.

A mineral slurry data bank, the most comprehensive compilation of hydraulic transportation data available, has been developed. An experimental pneumatic pipeline system for horizontal transport under either vacuum or pressure has been installed to determine air requirements and haulage capabilities as influenced by pipe and coal variables.

A coal mine systems simulator, which is needed for improved mine design and operational planning, and an underground coal production submodel have been developed. These provide a means for obtaining quicker and more accurate data to evaluate the effect of potential system changes on the health and safety and economics of underground coal mining operations. In metal and nonmetal mine research, a technique for nondestructively analyzing percent alpha quartz collected on field filter samples of respirable dust was developed. The ongoing contract to develop a passive personal dosimeter for nuclear radiation continued to progress with the assembly of a unit to effectively deal with radon daughter plate-out problems. Studies to determine with models the optimum configurations of different rectangular shaft timber supports, linings, and fixtures demonstrated that airway resistance could be reduced up to 25% by modifications which are relatively minor and can be readily applied in mines with severe ventilation problems.

Rock noise source location techniques for use in deep metal mines have been improved and simplified, and the necessary equipment for field application has become available at reasonable cost so that the microseismic technique is now a practical engineering tool. Closely related research on rock bursts in the Coeur d'Alene district shows that stope pillar distressing reduces the frequency and intensity of damaging bursts in the working area.

Explosives and Explosions.—A program has been initiated to develop methods of identifying the type and source of explosives from the products left after detonation. Such methods will provide improved control of explosives from two aspects—illegal explosives used in subversive activities and the use of nonpermissible explosives in gassy mines. The technique under study involves mixing phosphor-impregnated ceramic beads into the explosive formulation. These phosphor grains can be identified after detonation using ultraviolet light. Work to date on the postdetonation identification of explosives showed that suitable coated phosphors can be detected in concentrations as low as 0.02% by weight following detonation. Considerable interest has been shown by the explosives industry in the Bureau work in this area.

Two new high-density, water-gel explosives were formulated, offering an explosive strength of 120% TNT, relatively low sensitivity, and good toxic fume characteristics. These high-strength gels should gain widespread acceptance in both open pit blasting and underground noncoal mines in view of the improved fume characteristics.

An investigation was completed for the U.S. Coast Guard evaluating the causes of explosions observed during unconfined liquefied natural gas spills on water. Results indicate that the explosion hazard is real, although the amount of released energy is small. Explosions have been observed only with "weathered" liquefied natural gas (LNG) in which the methane content has been reduced significantly. Layering and downwind spread of flammable vapors are significant hazards.

A definitive test for the incendivity of detonators was developed and a number of detonators checked to ascertain the risk of methane-air ignition. A detonator design is not considered acceptable if two detonators fired simultaneously will ignite a methane-air mixture. Certain types of detonators in current use have been identified as especially hazardous because a single detonator will cause ignition.

LEGISLATION AND GOVERNMENT PROGRAMS

During 1972 the President continued the Phase II controls, which were begun at the end of the 90-day freeze of Phase I. Phase II was based on voluntary support; it was geared to encourage the expansion of output and employment; and it was a temporary program.

Phase II relaxed the Phase I controls. Some pay increases greater than 5.5% were allowed, and price increases were handled on a firm-by-firm basis. Within the controlled area, firms and bargaining units were divided into three groups. Large firms were required to give advance notice of price or wage increases; those in the middle group were not required to give advance notice unless they requested an exception, but they were required to file reports of increases; the third group, which consisted of the smallest units, was not required to file reports, but their actions were open to spot checks. Phase II with modifications continued through 1972.

Legislation affecting the mineral sector and approved during the second session of the 92d Congress covered such areas as the environment, water, public land, black-lung disease benefits, pipeline safety, consumer safety, the price of gold, the strategic stockpile and a few other areas.

The environment was the concern of several laws. Public Law 92-500, Water Pollution Control, was passed over a Presidential veto. To be administered by the Environmental Protection Agency (EPA), it provided money for acid mine water pollution control projects; required the use of the best practicable control technology for waste discharges by July 1, 1977; and the use of the best available control technology by July 1, 1983. It also transferred the discharge permit program under the Refuse Act from the Corps of Engineers to EPA. Public Law 92–574, Proposed Environmental Noise Control Act of 1972, was passed by Congress on October 18, and signed into law by the President on October 27. It required the EPA administrator to develop and publish criteria for noise; he was also given the responsibility for establishing noise emission standards. Public Law 92–307, Interim Operating Licenses for Nuclear Power Plants, amended the Atomic Energy Act of 1954 to authorize the Atomic Energy Commission (AEC) to issue temporary operating licenses for nuclear power reactors to avoid severe power shortages, provided adequate protection for the environment is assured.

Other measures approved which may be of interest to the mineral industries included Public Law 92–287, which established a Bureau of Mines metallurgy research center on the Fort Douglas Military Reservation in Utah to replace the one on the University of Utah Campus; and Public Law 92–285, Public Law 92–355, and Public Law 92–356, which authorized disposal from the national stockpile of zinc, nickel and lead. A listing of mineral related Federal legislation signed into law during 1972 follows:

Public Law (P.L.) and description	Signed into law
Environmental quality:	
P.L. 92–307.—Authorizing AEC to issue temporary operating licenses for nuclear power reactors.	June 2
P.L. 92–500.—Proposed Federal Water Pollution Control Act Amendments of 1972.	Oct. 18
P.L. 92–532.—To ban the unregulated dumping of materials into the oceans, estuaries, and Great Lakes.	Oct. 23
P.L. 92–574.—Proposed Environmental Noise Control Act of 1972.	Oct. 27
P.L. 92–583.—Authorizing funds for fiscal year 1973 to assist States in establishing and administering coastal zone and estuarine management programs.	Oct. 27
Water resources:	
P.L. 92–273.—Authorizing $26.8 million for the saline water conversion program for fiscal year 1973.	April 17
P.L. 92–396.—To increase authorizations for activities of the Water Resources Council.	Aug. 20
P.L. 92–577.—Authorizing the Secretary of the Interior to engage in feasibility investigations of certain potential water resource developments.	Oct. 27
Public lands:	
P.L. 92–230.—To designate Pine Mountain Wilderness within and as a part of Prescott and Tonto National Forests, Arizona.	Feb. 15
P.L. 92–241.—To designate Sycamore Canyon Wilderness, the Coconino, Kalibab, and Prescott National Forests, Arizona.	Mar. 6
P.L. 92–395.—To designate as wilderness national forest lands known as the Lincoln Back Country and parts of the Lewis and Clark and Lolo National Forests in Montana.	Aug. 20
P.L. 92–400.—To establish the Sawtooth National Recreation Area in Idaho.	Aug. 22
Indian lands:	
P.L. 92–431.—To authorize longer term leases of Indian lands located outside the boundaries of Indian reservations in New Mexico.	Sept. 26
National stockpile:	
P.L. 92–283.—Authorizing the disposal of 515,200 short tons of zinc from the national stockpile.	April 26
P.L. 92–355.—Authorizing the disposal of nickel from the national stockpile.	July 26
P.L. 92–356.—Authorizing the disposal of lead from the national stockpile and supplemental stockpile.	July 26
Health and safety:	
P.L. 92–303.—To amend the Federal Coal Mine Health and Safety Act so as to extend black-lung benefits to orphans whose fathers died of pneumoconiosis.	May 19
P.L. 92–401.—Extending time in which States may certify that their laws conform to the Natural Gas Pipelines Safety Act.	Aug. 22
P.L. 92–573.—To protect consumers against unreasonable risk of injury from hazardous products.	Oct. 27
Gold and medallions:	
P.L. 92–228.—To provide for the striking of medals in commemoration of the bicentennial of American independence.	Feb. 15
P.L. 92–268.—Increasing from $35 to $38 per ounce the price of gold, thus modifying the par value of the dollar.	Mar. 31

Public Law (P.L.) and description	Signed into law
Miscellaneous:	
P.L. 92–287.—To establish a metallurgy research center on the Fort Douglas Military Reservation, Utah, and convey certain lands to the University of Utah.	May 1
P.L. 92–322.—Granting congressional consent to a 3-year extension of interstate compact to conserve oil and gas.	June 30
P.L. 92–325.—Extending the Defense Production Act for two additional years through fiscal year 1974.	June 30

The acquisition cost of strategic materials in government inventories totaled $5.9 billion with a market value of $6.7 billion as of December 31, 1972. Materials in these government inventories with a market value of $2.7 billion were considered in excess of stockpile needs. In calendar year 1972, the Government disposed of $289 million worth of mineral commodities, a 23% increase from the 1971 figure. Major mineral stockpile items sold during the year with a sales value of at least $10 million each included cobalt, industrial diamonds, lead, and metallurgical manganese. Sales of nickel had a value greater than $100 million, and zinc sales were greater than $60 million.

WORLD REVIEW

World Economy.—The long-run growth in world trade continued through 1972, despite conditions that necessitated governmental actions concerning exchange rates and capital movements. Exchange rates during the year were governed by the Smithsonian agreement, which was a set of "central" rates set up just before the beginning of the year to replace the pattern of floating exchange rates that came into being after the United States suspended the convertibility of the dollar in August 1971. The central rates provided an effective revaluation of major currencies. The foreign exchange markets were calmer during the later part of the year.

Inflation continued to be a major world economic problem during 1972. The countries of the European Economic Community (EEC), concerned about inflation, agreed to a program of coordinated anti-inflationary efforts.

Moderate economic growth continued to be the pattern for most developed countries. Canada had an increase in industrial production of 6.7%; the increase for Japan was 6.8%. Spain had a notably large increase in industrial production of 17.6%.

World Production.—The United Nations (UN) indexes of world mineral industry production (1963 = 100) for the extractive industries increased 4 index points to 155 in 1972. In the metals category world production remained constant. There were increases in the metal production of Communist Europe and decreases in the non-Communist world. The total output of coal declined two points to 103 during 1972. The non-Communist world declined in coal production, although the United States-Canada and the Australia-New Zealand coal production indexes increased significantly. Coal production in Communist Europe increased slightly. World production of crude petroleum and natural gas increased 7 index points to 184. All areas increased their output with the exception of Latin America, which declined 6 index points to 112. Overall industrial production as measured by the UN index rose 11 points to 176 during 1972. It should be noted that, this year, more countries are included in the EEC and fewer in the European Free Trade Association than in previous years. Denmark, Ireland and the United Kingdom recently joined the EEC and are now included in these indexes. Denmark and the United Kingdom are no longer included under the European Free Trade Association.

World Trade.—The value of world trade in all commodities increased almost 12% to $348.1 billion in 1971. Exports of mineral commodities increased more than 8% to $73.9 billion. During 1971 metal exports declined over 4% to $35.6 billion. This is only 48% of the mineral commodity trade. In the past, metals have usually accounted for more than 50% of this trade. Within the metals group, all ores, concentrates, and scrap exports declined 8%, iron and steel exports increased almost 5%, and nonferrous metals exports declined almost 15%. Nonmetal exports increased almost

5% to \$2.5 billion. World trade in mineral fuels increased 25% to \$35.8 billion. This is larger by \$0.2 billion than metal exports, which in the past accounted for the largest share of this trade.

World Prices.—The mineral commodity export price indexes (1963=100) for fuels and all crude minerals increased 12.6% and 11.0% respectively, while that for metal ores increased only 6.3% during 1972.

The price index for metals increased 8 index points to 134. The index for fuels increased 16 index points to 143 and that for all crude minerals increased 14 index points to 141. Total minerals prices increased significantly in both developed and developing areas. Nonferrous base metal prices remained nearly constant, declining 1 index point in developed areas and increasing 1 index point in developing areas.

Table 1.—Value of mineral production,[1] exports, and imports, by group

(Million dollars)

	1968			1969			1970		
	Production	Exports [2]	Imports [2]	Production	Exports [2]	Imports [2]	Production	Exports [2]	Imports [2]
Metals and nonmetals except fuels:									
Nonmetals	5,449	246	490	5,624	222	491	r 5,712	225	551
Metals	r 2,698	241	1,161	r 3,333	246	1,094	r 3,928	322	1,249
Total [3]	r 8,147	487	1,651	r 8,957	467	1,586	r 9,640	547	1,799
Mineral fuels	16,820	539	1,309	17,965	632	1,428	20,152	1,120	1,567
Grand total [3]	r 24,966	1,026	2,960	26,921	1,099	3,014	r 29,792	1,667	3,366

	1971			1972		
	Production r	Exports [2]	Imports [2]	Production	Exports [2]	Imports [2]
Metals and nonmetals except fuels:						
Nonmetals	6,058	226	573	6,492	152	646
Metals	3,403	192	1,047	3,641	152	988
Total	9,461	418	1,620	10,133	304	1,634
Mineral fuels	21,247	r 1,020	2,076	22,084	1,106	2,856
Grand total [3]	30,708	r 1,438	3,696	32,217	1,411	4,490

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.

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

(Million dollars)

Mineral group	1968	1969	1970	1971	1972 p
Metals and nonmetals except fuels:					
Nonmetals	5,374	5,498	r 5,535	5,646	5,859
Metals	r 2,570	r 2,965	r 3,052	2,742	3,104
Total	r 7,944	r 8,463	r 8,587	8,388	8,963
Mineral fuels	16,753	16,948	18,074	17,735	18,057
Grand total	r 24,697	r 25,411	r 26,661	26,123	27,020

p Preliminary. r Revised.
[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)

	1968	1969	1970	1971	1972 p
METALS					
Ferrous	102.4	110.9	109.3	96.9	98.4
Nonferrous:					
Base	120.4	149.6	167.3	151.0	162.8
Monetary	97.1	115.5	123.9	108.6	102.7
Other	113.9	111.0	119.5	115.5	112.4
Average	117.6	141.7	157.4	143.0	151.1
Average, all metals	110.8	127.9	135.8	122.3	127.5
NONMETALS					
Construction	104.6	106.6	103.1	106.2	112.1
Chemical	98.9	101.4	103.1	101.9	108.5
Other	106.5	107.3	109.1	105.5	112.5
Average	103.4	105.5	103.4	105.2	111.3
FUELS					
Coal	98.5	100.9	108.3	98.9	105.0
Crude oil and natural gas	104.2	110.5	112.0	111.3	111.4
Average	103.4	109.1	111.7	109.7	111.0
Average, all minerals	104.1	110.1	112.1	109.9	112.6

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

Table 4.—Federal Reserve Board indexes of industrial production, mining, and selected minerals and mineral fuels related energies

(1967 = 100)

	1968	1969	1970	1971	1972 p
Mining:					
Coal	98.2	101.1	105.7	99.8	103.2
Crude oil and natural gas:					
Crude oil	103.2	104.8	109.4	108.3	107.3
Gas and gas liquids: Average [1]	104.0	106.9	109.7	111.3	110.0
Average coal, oil, and gas	103.2	106.1	109.2	107.6	109.1
Metal	111.4	124.8	131.3	121.4	120.8
Stone, and earth minerals	103.7	102.8	98.8	93.2	94.0
Average	106.8	111.7	112.0	104.6	104.9
Average mining	103.9	107.2	109.7	107.0	108.2
Industrial production:					
Primary metals	103.2	114.1	106.9	100.9	113.1
Iron and steel	103.6	113.0	105.3	96.6	107.1
Nonferrous metals and products	102.6	116.0	109.7	108.7	123.9
Clay, glass, and stone products	106.0	112.5	106.3	110.0	117.7
Average industrial production	105.8	110.7	106.7	106.8	114.4

p Preliminary.
[1] Includes oil and gas drilling.

Source: Federal Reserve System, Board of Governors. Federal Reserve Bulletin. V. 59, No. 3, March 1973, pp. A60–61. Detailed Industrial Production Series, January 1954–March 1971, 1971 Revision. Federal Reserve Statistical Release, January 15 and April 16, 1973.

Table 5.—Federal Reserve Board monthly indexes of mining production, seasonally adjusted

(1967 =100)

Month	Total mining[1]		Coal, oil, gas		Coal		Crude oil and natural gas: Total[2]		Crude oil and natural gas: Crude oil		Metal, stone, earth minerals		Metal mining		Stone and earth minerals	
	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972
January	111.1	107.3	110.6	107.1	112.3	106.3	110.3	107.1	111.1	104.0	113.6	108.0	140.1	128.9	95.6	93.8
February	110.1	107.2	109.3	106.5	108.8	99.6	109.3	107.4	110.1	104.2	113.6	109.8	139.0	133.7	96.3	93.5
March	111.4	108.5	111.4	108.6	116.2	104.1	110.6	109.6	112.7	106.9	111.6	108.3	135.1	131.0	95.6	92.7
April	110.4	109.0	111.4	110.0	115.5	112.9	114.3	110.7	111.9	108.1	106.5	104.6	124.7	122.2	94.2	92.6
May	108.6	107.9	109.6	109.9	110.2	105.0	109.6	112.5	109.5	109.5	104.6	99.4	122.6	110.7	92.4	91.7
June	108.9	108.2	109.9	110.5	109.4	109.1	110.0	112.4	109.8	108.9	104.9	99.6	117.3	102.9	96.4	97.4
July	105.7	107.9	109.2	111.0	109.4	114.4	109.2	111.0	107.8	107.4	91.6	95.8	93.5	102.2	90.2	91.6
August	106.5	107.7	108.9	109.3	109.4	97.2	108.8	111.9	107.0	107.8	96.8	101.0	104.8	115.2	91.4	91.4
September	106.0	110.2	108.0	111.1	109.7	104.2	107.7	112.8	104.7	108.0	98.1	106.5	109.7	123.4	90.1	94.9
October	97.7	110.0	96.7	110.9	29.1	99.3	107.3	113.9	105.4	108.7	102.0	106.2	117.1	122.3	91.7	95.2
November	102.3	110.1	100.2	109.2	55.7	101.0	107.2	111.8	105.0	108.1	110.9	113.0	136.7	136.7	93.4	97.0
December	107.7	108.3	106.8	106.8	112.4	97.1	106.0	109.5	104.2	106.5	111.1	114.6	137.7	141.8	92.7	96.0
Average	107.0	p 108.3	107.5	p 109.2	99.0	p 103.2	111.3	110.8	108.3	107.3	104.6	p 104.8	121.4	p 120.8	93.2	p 93.9

p Preliminary.
[1] Including fuels.
[2] Total includes oil and gas drilling.

Source: Board of Governors, Federal Reserve System, Federal Reserve Bulletin. V. 59, No. 3, March 1973, pp. A60–61. Federal Reserve Monthly Statistical Release, March 16, 1973.

Table 6.—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]		Total
					Hydropower	Nuclear power	
1968	291	13,664	21,548	18,593	2,349	130	56,575
1969	266	13,957	22,838	18,886	2,648	146	58,741
1970	247	14,820	24,154	19,772	r 2,630	229	r 61,852
1971	222	13,385	24,805	19,322	2,825	404	60,963
1972 p	181	14,350	24,878	19,344	2,893	576	62,222

p Preliminary. r Revised.

[1] Heat values employed for bituminous coal and lignite are: 1968, 12,530 Btu per pound; 1969, 12,450 Btu; 1970, 12,290 Btu; 1971, 12,120 Btu; and 1972, 12,120 Btu.

[2] Heat values employed for crude petroleum are: 1968, 5,585,016 Btu per barrel; 1969, 5,601,070 Btu; 1970, 5,620,900 Btu; 1971, 5,594,100; and 1972, 5,598,100 Btu.

[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 and nuclear power is calculated from the kilowatt-hours produced, converted to theoretical energy resources inputs calculated from national average heat rates for fossil-fueled steam electric plants provided by the Federal Power Commission using 10,398 Btu per net kilowatt-hour in 1968; 10,447 Btu in 1969, and 10,494 Btu in 1970. Energy inputs for hydropower in 1971 and 1972 are converted at an average heat rate of 10,478 Btu per net kilowatt-hour generated. Energy inputs for nuclear power in 1971 and 1972 are converted at an average heat rate of 10,660 Btu per net kilowatt-hour based on information from the Atomic Energy Commission.

Table 7.—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	Natural gas, dry	Petroleum (excluding natural gas liquids)	Natural gas liquids	Electricity		Total
						Hydropower	Nuclear power	
				TRILLION BTU				
1968	258	12,401	19,580	24,607	2,445	2,342	130	r 61,763
1969	224	12,509	21,020	26,029	2,392	2,659	146	64,979
1970	210	12,488	22,029	r 27,049	2,488	2,650	229	r 67,143
1971	186	11,857	22,819	28,045	2,525	2,862	404	68,698
1972 p	150	12,454	23,125	30,381	2,584	2,972	576	72,242
				PERCENT				
1968	0.4	20.1	31.7	39.8	4.0	3.8	0.2	100.0
1969	.3	19.3	32.2	40.1	3.7	4.1	.2	100.0
1970	.3	18.6	32.8	r 40.3	3.7	r 4.0	.3	100.0
1971	.3	17.3	33.2	40.8	3.7	4.1	.6	100.0
1972 p	.2	17.2	32.0	42.1	3.6	4.1	.8	100.0

r Revised. p Preliminary.

[1] Heat values employed are: anthracite, 12,700 Btu per pound and bituminous coal and lignite, weighted average Btu provided by the Division of Fossil Fuels, Branch of Coal, 12,430 Btu per pound in 1968; 12,330 Btu per pound in 1969; 12,110 Btu per pound in 1970; and 11,980 Btu per pound in 1971 and 1972. Weighted average Btu for petroleum products obtained by using 5,248,000 Btu per barrel for gasoline and naphtha-type jet fuel, 5,670,000 for kerosine and kerosine-type jet fuel; 5,825,000 for distillate; 6,287,000 residual; 6,064,800 for lubricants; 5,537,280 for wax; 6,636,000 for asphalt; and 5,796,000 for miscellaneous. Natural gas dry, 1,032 Btu in 1968 and 1,031 Btu per cubic foot thereafter; natural gas liquids weighted average Btu; natural gasoline and cycle products, 110,000 Btu per gallon; LP-gases 95,000 per gallon; and ethane 73,390 Btu per gallon. Hydropower (adjusted for net imports or net exports) and nuclear power are derived from net electricity 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 using 10,398 Btu per net kilowatt-hour in 1968; 10,447 Btu in 1969, and 10,494 Btu in 1970. Energy inputs for hydropower in 1971 and 1972 are converted at an average heat rate of 10,478 Btu per net kilowatt-hour generated. Energy inputs for nuclear power in 1971 and 1972 are converted at an average heat rate of 10,660 Btu per net kilowatt-hour based on information from the Atomic Energy Commission.

Table 8.—Gross consumption of energy resources, by major sources and consuming sectors [1]

(Trillion Btu)

Year	Anthracite	Bituminous coal and lignite	Natural gas, dry [1]	Petroleum [2]	Hydropower [3]	Nuclear power [3]	Total gross energy inputs [4]	Utility electricity distributed [5]	Total sector energy inputs [6]
HOUSEHOLD AND COMMERCIAL									
1968	121	408	6,451	6,128	--	--	13,108	2,467	15,575
1969	107	340	6,890	6,268	--	--	13,605	2,752	16,357
1970	103	324	7,108	6,453	--	--	13,988	3,000	16,988
1971	98	308	7,366	6,440	--	--	14,212	3,209	17,421
1972 p	75	320	7,642	6,735	--	--	14,772	3,482	18,254
INDUSTRIAL									
1968	80	5,044	9,274	4,820	35	--	19,253	2,044	21,297
1969	70	4,981	9,885	5,047	34	--	20,017	2,155	22,172
1970	59	4,943	10,161	r 5,061	34	--	r 20,258	2,210	r 22,468
1971	47	4,256	10,570	5,094	34	--	20,001	2,293	22,294
1972 p	35	4,342	10,591	5,606	36	--	20,610	2,488	23,098
TRANSPORTATION [7]									
1968	NA	11	610	14,681	--	--	15,302	18	15,320
1969	NA	8	651	15,249	--	--	15,908	17	15,925
1970	NA	8	745	15,720	--	--	16,473	16	16,489
1971	NA	6	766	16,286	--	--	17,058	17	17,075
1972 p	NA	4	790	17,318	--	--	18,112	18	18,130
ELECTRICITY GENERATION, UTILITIES [3]									
1968	56	6,938	3,245	1,181	2,307	130	13,857	4,529	--
1969	47	7,180	3,594	1,628	2,625	146	15,220	4,924	--
1970	48	7,213	4,015	2,087	2,616	229	16,208	5,226	--
1971	42	7,288	4,117	2,543	2,828	404	17,222	5,519	--
1972 p	40	7,787	4,102	3,141	2,937	576	18,583	5,988	--
MISCELLANEOUS AND ACCOUNTED FOR									
1968	1	--	--	242	--	--	243	--	--
1969	--	--	--	229	--	--	229	--	--
1970	--	--	--	r 216	--	--	r 216	--	--
1971	--	--	--	207	--	--	207	--	--
1972 p	--	--	--	165	--	--	165	--	--

See footnotes at end of table.

Table 8.—Gross consumption of energy resources, by major sources and consuming sectors [1]—Continued

(Trillion Btu)

Year	Anthracite	Bituminous coal and lignite	Natural gas, dry [1]	Petroleum [2]	Hydropower [3]	Nuclear power [3]	Total gross energy inputs [4]	Utility electricity distributed [5]	Total sector energy inputs [6]
TOTAL GROSS ENERGY INPUTS [8]									
1968	258	12,401	19,580	27,052	2,342	130	61,763	--	--
1969	224	12,509	21,020	28,421	2,659	146	64,979	--	--
1970	210	12,488	22,029	r 29,537	2,650	229	r 67,143	--	--
1971	186	11,857	22,819	30,570	2,862	404	68,698	--	--
1972 p	150	12,454	23,125	32,965	2,972	576	72,242	--	--

p Preliminary. r Revised. NA Not available.

[1] Excludes natural gas liquids.

[2] Petroleum products including still gas, liquefied refining gas (LRG), and natural gas liquids.

[3] Represents outputs of hydropower (adjusted for net imports or net exports) and nuclear power converted to theoretical energy inputs calculated from national average heat rates for fossil-fueled steam-electric plants provided by the Federal Power Commission using 10,398 Btu per net kilowatt-hour in 1968; 10,447 Btu in 1969; and 10,494 in 1970. Energy inputs for hydropower in 1971 and 1972 are converted at an average heat rate of 10,478 Btu per net kilowatt-hour generated. Energy inputs for nuclear power in 1971 and 1972 are converted at an average heat rate 10,660 Btu per net kilowatt-hour based on information from the Atomic Energy Commission. Excludes inputs for power generated by nonutility fuel-burning plants which are included within the other consuming sectors.

[4] Gross energy is that contained in all types of commercial energy at time it is incorporated in the economy, whether energy is produced domestically or imported. Gross energy comprises inputs of primary fuels (or the derivatives) and outputs of hydropower and nuclear power converted to theoretical energy inputs. Gross energy includes energy used for production, processing, and transportation of energy proper.

[5] Utility electricity, generated and imported, distributed to the other consuming sectors as energy resource inputs. Distribution to sectors is based on historical series in the Edison Electric Institute Yearbook. Conversion of electricity to energy equivalent by sectors was made at the value of contained energy corresponding to 100% efficiency using a theoretical rate of 3,412 Btu per kilowatt-hour.

[6] Energy resource inputs by sector, including direct fuels and electricity distributed.

[7] Includes bunkers and military transportation.

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

Table 9.—Domestic supply and demand for coal

	1971		1972 p	
	Thousand short tons	Trillion Btu	Thousand short tons	Trillion Btu
ANTHRACITE				
Supply:				
Production [1]	8,727	221.7	7,106	180.5
Exports [2]	−1,389	−35.3	−1,191	−30.3
Imports	--	--	--	--
Stock change: withdrawals (+), additions (−)	NA	NA	NA	NA
Losses, gains, unaccounted for	--	--	--	--
Total	7,338	186.4	5,915	150.2
Demand by major consuming sectors: [3]				
Household and commercial [4]	3,850	97.8	2,960	75.2
Industrial [5]	1,842	46.8	1,371	34.8
Transportation [6]	(7)	(7)	(7)	(7)
Electricity generation, utilities	1,646	41.8	1,584	40.2
Total	7,338	186.4	5,915	150.2
BITUMINOUS COAL AND LIGNITE				
Supply:				
Production [1]	552,192	13,385.1	592,000	14,350.1
Exports	−56,633	−1,533.5	−55,960	−1,515.3
Imports	111	2.7	47	1.1
Stock change: withdrawals (+), additions (−)	2,553	57.0	−24,123	−538.8
Losses, gains unaccounted for	−3,361	−54.4	7,812	156.7
Total	494,862	11,856.9	519,776	12,453.8
Demand by major consuming sectors:				
Fuel and power:				
Household and commercial [4]	11,351	307.7	11,748	320.4
Industrial [5]	152,747	4,139.9	154,613	4,215.9
Coal carbonized for coke [8]	(82,809)	(2,244.4)	(87,272)	(2,379.6)
Transportation [6]	207	5.6	163	4.4
Electricity generation, utilities	326,280	7,287.8	348,612	7,786.6
Total	490,585	11,741.0	515,136	12,327.3
Raw material: Industrial: [9]				
Crude light oil	1,008	27.3	1,071	29.2
Crude coal tar	3,269	88.6	3,569	97.3
Total	4,277	115.9	4,640	126.5
Total	494,862	11,856.9	519,776	12,453.8

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 commercial users, with some unknown portion of use by small industries.
[5] Includes consumption by coke plants, steel and rolling mills, and other industrial uses.
[6] Includes bunkers and military transportation.
[7] Data not available. Believed to be small and of minor significance.
[8] Figures in parentheses are not added into totals.
[9] Coal equivalent based on Btu value of raw materials used for coal chemicals.

Table 10.—Domestic supply and demand for natural gas

	1971		1972 p	
	Million cubic feet	Trillion Btu	Million cubic feet	Trillion Btu
Supply:				
Production [1]	22,493,012	24,805.0	22,531,698	24,878.3
Exports	−80,212	−82.7	−78,013	−80.4
Imports	934,548	963.5	1,019,496	1,051.1
Stock change: Withdrawals (+), additions (−)	−331,768	−342.1	−135,734	−139.9
Transfers out, extraction loss [2]	−883,127	−2,525.1	−907,993	−2,584.3
Losses, gains, unaccounted for	--	--	--	--
Total	22,132,453	22,818.6	22,429,454	23,124.8
Demand by major consuming sectors:				
Fuel and power:				
Household and commercial	7,144,389	7,365.9	7,412,543	7,642.4
Industrial [3]	9,603,790	9,901.5	9,618,143	9,916.3
Transportation	742,592	765.6	766,156	789.9
Electricity generation, utilities	3,992,983	4,116.8	3,978,673	4,102.0
Total	21,483,754	22,149.8	21,775,515	22,450.6
Raw material: Industrial: [4]				
Carbon black	63,699	65.7	53,939	55.6
Other chemicals [5]	585,000	603.1	600,000	618.6
Total	648,699	668.8	653,939	674.2
Grand total	22,132,453	22,818.6	22,429,454	23,124.8

p Preliminary.

[1] Marketed production includes wet gas sold or consumed by producers, losses in transmission, producers' additions to storage, and increases in gas pipeline fill; excludes repressuring and quantities vented and flared. Btu value of production is for wet gas prior to extraction of natural gas liquids. Higher Btu values assigned to extraction loss are reflected in 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, and annual outputs of ethane at 73,390 Btu per gallon. (Prior to 1967, ethane production was included with LPG in converting to Btu values.)

[3] Includes transmission losses of 338,999 million cubic feet in 1971 and 328,002 million cubic feet in 1972.

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

[5] Estimated from partial data.

Note: Conversion factor for dry gas is 1,031 Btu per cubic foot.

Table 11.—Domestic supply and demand for petroleum [1]

	1971		1972 p	
	Million barrels	Trillion Btu	Million barrels	Trillion Btu
Supply:				
Crude oil: [2]				
Production	3,453.9	19,321.6	3,455.4	19.343.8
Exports	–.5	–2.8	–.2	–1.1
Imports [3]	613.4	3,431.4	811.1	4,540.6
Stock change: withdrawals (+), additions (–)	16.7	93.4	13.3	74.5
Losses, transfers for use as crude, and unaccounted for	4.3	24.0	1.3	7.2
Total	4,087.8	22,867.6	4,280.9	23,965.0
Petroleum input runs to stills:				
Crude oil	4,087.8	22,867.6	4,280.9	23.965.0
Transfers in, natural gas liquids [4]	284.9	1,267.9	302.4	1,345.4
Other hydrocarbons	6.1	34.1	10.1	56.0
Total	4,378.8	24,169.6	4,593.4	25,366.4
Output:				
Refined products	4,378.8	24,169.6	4,593.4	25,366.4
Unfinished oils, net	43.6	274.1	51.5	323.8
Overage or loss	139.4	769.4	142.2	785.3
Total	4,561.8	25,213.1	4,787.1	26,475.5
Exports	–81.3	–466.1	–81.3	–463.3
Imports	819.5	4,974.2	924.1	5,571.0
Stock change, including natural gas liquids	–42.8	–201.9	71.7	403.1
Transfers in, natural gas liquids [4] [5]	332.9	1.257.2	335.8	1.238.9
Losses, gains unaccounted for	–37.5	–206.5	–47.2	–259.8
Total	5,552.6	30,570.0	5,990.2	32,965.4
Demand by major consuming sectors:				
Fuel and power:				
Household and commercial	959.5	5,331.3	1,014.6	5,598.1
Industrial	537.7	3,196.3	587.7	3,489.0
Transportation [6]	3,011.2	16,159.5	3,198.9	17,182.6
Electricity generation, utilities	407.1	2,543.1	503.7	3,141.2
Other, not specified	22.9	124.7	15.8	80.6
Total	4,938.4	27,354.9	5,320.7	29,491.5
Raw Material: [7]				
Petrochemical feedstock offtake	320.2	1,373.2	360.6	1,541.6
Other nonfuel use	279.1	1,759.9	293.5	1,847.6
Total	599.3	3,133.1	654.1	3,389.2
Miscellaneous and unaccounted for	14.9	82.0	15.4	84.7
Grand total	5,552.6	30,570.0	5,990.2	32,965.4

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 LRG; also natural gas liquids transferred from natural gas.

[2] Btu value for crude oil for each year shown is based on average Btu value of total output of petroleum products (including refinery fuel and losses) adjusted to exclude natural gas liquids inputs and their implicitly derived values. Value for net imports or crude is based on the average value of crude runs to stills.

[3] Includes some Athabasca hydrocarbons.

[4] Btu values for natural gas liquids for each year shown are implicitly derived from weighted averages of production of major natural gas liquids, derived by converting natural gasoline and cycle products at 110,000 Btu per gallon, LPG at 95,000 Btu per gallon, and ethane at 73,390 Btu per gallon.

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

[6] Includes bunkers and military transportation.

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

Table 12.—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
1971												
Fuel and power:												
Liquefied gases	182.6	732.4	26.6	106.7	31.5	126.3	--	--	6.4	25.7	247.1	991.1
Jet fuels:												
Naphtha type	--	--	--	--	94.7	497.1	--	--	--	--	94.7	497.1
Kerosine type	--	--	--	--	274.0	1,553.6	--	--	--	--	274.0	1,553.6
Total	--	--	--	--	368.7	2,050.7	--	--	--	--	368.7	2,050.7
Gasoline	--	--	--	--	2,213.2	11,614.9	--	--	--	--	2,213.2	11,614.9
Kerosine	70.7	400.9	20.2	114.5	--	--	--	--	--	--	90.9	515.4
Distillate fuel	523.6	3,050.0	113.6	661.7	288.6	1,681.1	35.3	205.6	10.2	59.4	971.3	5,657.8
Residual fuel	182.6	1,148.0	168.1	1,056.9	109.2	686.5	371.8	2,337.5	6.3	39.6	838.0	5,268.5
Still gas	--	--	157.0	942.0	--	--	--	--	--	--	157.0	942.0
Petroleum coke	--	--	52.2	314.5	--	--	--	--	--	--	52.2	314.5
Total	959.5	5,331.3	537.7	3,196.3	3,011.2	16,159.5	407.1	2,543.1	22.9	124.7	4,938.4	27,354.9
Raw material: [3]												
Special naphthas	--	--	29.8	156.4	--	--	--	--	--	--	29.8	156.4
Lubes [4] and waxes	--	--	33.7	201.6	20.9	126.8	--	--	--	--	54.6	328.4
Petroleum coke [5]	--	--	27.7	166.9	--	--	--	--	--	--	27.7	166.9
Asphalt and road oil	167.0	1,108.2	--	--	--	--	--	--	--	--	167.0	1,108.2
Petrochemical feedstock offtake:												
Liquefied refinery gas [6]	--	--	32.2	116.6	--	--	--	--	--	--	32.2	116.6
Liquefied petroleum gas [6] [7]	--	--	177.5	642.9	--	--	--	--	--	--	177.5	642.9
Naphtha (−400 degrees)	--	--	56.8	298.1	--	--	--	--	--	--	56.8	298.1
Still gas	--	--	16.2	97.2	--	--	--	--	--	--	16.2	97.2
Miscellaneous (+400 degrees)	--	--	37.5	218.4	--	--	--	--	--	--	37.5	218.4
Total	167.0	1,108.2	411.4	1,898.1	20.9	126.8	--	--	--	--	599.3	3,133.1
Miscellaneous and unaccounted for	--	--	--	--	--	--	--	--	14.9	82.0	14.9	82.0
Grand total domestic product demand	1,126.5	6,439.5	949.1	5,094.4	3,032.1	16,286.3	407.1	2,543.1	37.8	206.7	5,552.6	30,570.0

1972 p												
Fuel and power:												
Liquefied gases	212.0	850.3	31.0	124.3	33.0	132.4	--	--	7.1	28.5	283.1	1,135.5
Jet fuels:												
Naphtha type	--	--	--	--	88.5	473.9	--	--	--	--	88.5	473.9
Kerosine type	--	--	--	--	294.0	1,667.0	--	--	--	--	294.0	1,667.0
Total	--	--	--	--	382.5	2,140.9	--	--	--	--	382.5	2,140.9
Gasoline	--	--	--	--	2,350.4	12,334.9	--	--	--	--	2,350.4	12,334.9
Kerosine	63.9	362.3	22.0	124.7	--	--	--	--	--	--	85.9	487.0
Distillate fuel	560.0	3,262.0	125.0	728.1	320.0	1,864.0	55.3	322.1	5.7	33.2	1,066.0	6,209.4
Residual fuel	178.7	1,123.5	182.5	1,147.4	113.0	710.4	448.4	2,819.1	3.0	18.9	925.6	5,819.3
Still gas	--	--	171.0	1,026.0	--	--	--	--	--	--	171.0	1,026.0
Petroleum coke	--	--	56.2	338.5	--	--	--	--	--	--	56.2	338.5
Total	1,014.6	5,598.1	587.7	3,489.0	3,198.9	17,182.6	503.7	3,141.2	15.8	80.6	5,320.7	29,491.5
Raw material: [3]												
Special naphthas	--	--	31.9	167.4	--	--	--	--	--	--	31.9	167.4
Lubes [4] and waxes	--	--	35.9	214.9	22.3	135.2	--	--	--	--	58.2	350.1
Petroleum coke [5]	--	--	32.1	193.4	--	--	--	--	--	--	32.1	193.4
Asphalt and road oil	171.3	1,136.7	--	--	--	--	--	--	--	--	171.3	1,136.7
Petrochemical feedstock offtake:												
Liquefied refinery gas [6]	--	--	36.7	131.9	--	--	--	--	--	--	36.7	131.9
Liquefied petroleum gas [6 7]	--	--	200.0	718.9	--	--	--	--	--	--	200.0	718.9
Naphtha (−400 degrees)	--	--	58.1	304.9	--	--	--	--	--	--	58.1	304.9
Still gas	--	--	14.7	88.2	--	--	--	--	--	--	14.7	88.2
Miscellaneous (+400 degrees)	--	--	51.1	297.7	--	--	--	--	--	--	51.1	297.7
Total	171.3	1,136.7	460.5	2,117.3	22.3	135.2	--	--	--	--	654.1	3,389.2
Miscellaneous and unaccounted for	--	--	--	--	--	--	--	--	15.4	84.7	15.4	84.7
Grand total domestic product demand	1,185.9	6,734.8	1,048.2	5,606.3	3,221.2	17,317.8	503.7	3,141.2	31.2	165.3	5,990.2	32,965.4

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

Table 13.—Net supply of principal minerals by components [1]

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

Commodity and mineral content measured	Total net supply 1971	Total net supply 1972 p	% change	Primary shipments 1971	Primary shipments 1972	Old scrap 1971	Old scrap 1972	Imports 1971	Imports 1972	Exports as % of gross supply 1971	Exports as % of gross supply 1972
FERROUS METALS											
Iron ore ____ thousand long tons	114,169	111,545	−2.3	66	69	--	--	34	31	3	2
Pig iron	81,604	89,670	+9.9	100	99	--	--	(2)	1	(2)	(2)
Steel ingot	r 135,611	147,853	+9.0	r 87	88	--	--	r 13	12	3	2
Chromite (Cr_2O_3)	555	481	−13.3	--	--	--	--	100	100	6	4
Cobalt	11	12	+9.1	r 53	52	--	--	r 47	48	4	8
Manganese	r 883	768	−13.0	(2)	(2)	--	--	100	100	6	3
Molybdenum	r 25	29	+16.0	99	99	--	--	1	1	r 48	44
Nickel	155	198	+27.7	9	8	12	14	79	78	14	10
Tungsten	3	6	+100.0	95	55	--	--	5	45	24	1
OTHER METALS											
Aluminum	r 4,451	4,831	+8.5	82	81	4	4	14	15	6	6
Antimony	31	43	+38.7	3	1	55	44	42	55	3	(2)
Beryl (BeO) ____ short tons	W	W	W	W	W	--	--	W	W	--	--
Cadmium ____ do	5,604	5,943	+6.0	69	81	--	--	31	19	1	8
Copper	2,261	2,433	+7.6	66	67	20	19	14	14	2	1
Lead	r 1,436	1,492	+3.9	40	40	41	40	19	20	r 2	3
Magnesium	103	101	−1.9	95	94	2	2	3	4	19	15
Mercury ____ 76-pound flasks	r 55,766	48,208	−13.6	28	15	27	26	45	59	r 11	1
Platinum group ____ thousand troy ounces	1,208	1,615	+33.7	2	2	17	13	81	85	25	25
Tin ____ thousand long tons	r 65	71	+9.2	NA	NA	30	28	70	72	r 3	2
Titanium concentrate (TiO_2):											
Ilmenite and slag	573	594	+3.7	68	69	--	--	32	31	(2)	(2)
Rutile	215	195	−9.3	--	--	--	--	100	100	--	--
Uranium concentrate (U_3O_8)	13	15	+15.4	93	85	--	--	7	15	--	--
Zinc	r 1,372	1,257	−8.4	36	38	6	6	58	56	1	(2)
NONMETALS											
Asbestos	760	815	+7.2	16	15	--	--	84	85	6	6
Barite, crude	1,309	1,530	+16.9	63	59	--	--	37	41	--	--
Bromine	178	193	+8.4	100	100	--	--	--	--	--	--
Clays	54,757	57,677	+5.3	100	100	--	--	(2)	(2)	4	3
Fluorspar, finished	1,332	1,429	+7.3	20	17	--	--	80	83	1	(2)
Gypsum	r 25,989	32,000	+23.1	77	76	--	--	23	24	(2)	(2)
Mica (except scrap)	119	126	+5.9	94	96	--	--	6	4	6	5
Phosphate rock (P_2O_5)	8,113	8,221	+1.3	99	100	--	--	1	(2)	34	36
Potash (K_2O equivalent)	4,794	4,814	(2)	48	47	--	--	52	53	11	14
Salt common,	47,262	47,616	+.7	92	93	--	--	8	7	1	2
Sand and gravel ____ million tons	r 919	912	−.8	100	100	--	--	(2)	(2)	(2)	(2)
Stone, crushed ____ do	r 875	923	+5.5	100	100	--	--	(2)	(2)	(2)	(2)
Sulfur, all forms ____ thousand long tons	9,473	9,532	+.6	87	90	--	--	13	10	14	16
Talc and allied minerals	918	965	+5.1	98	97	--	--	2	3	13	15

p Preliminary. r Revised. NA Not available. W Withheld to avoid disclosing company confidential data. Figure is not included in net and gross supply.

[1] Net supply is sum of primary shipments, secondary production, 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.

Table 14.—Shipments, net new orders, and yearend unfilled orders for selected mineral processing industries

(Million dollars)

Year and month	Shipments [1]			Net new orders			Unfilled orders at end of period		
	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]
1968	50,457	24,901	25,556	49,790	24,380	25,410	6,327	3,100	3,227
1969	57,137	26,493	30,644	58,491	27,821	31,210	7,657	3,896	3,761
1970	55,740	25,733	30,007	55,031	25,696	29,335	6,687	3,727	2,960
1971	58,546	27,563	30,983	r 54,537	r 26,362	r 28,175	r 6,043	r 3,432	r 2,611
1972	62,987	30,545	32,442	65,090	32,176	32,914	8,474	5,321	3,153
1972:									
January	4,704	2,192	2,512	4,644	2,167	2,477	5,983	3,407	2,576
February	4,798	2,305	2,493	4,888	2,391	2,497	6,073	3,493	2,580
March	4,933	2,380	2,553	5,243	2,547	2,696	6,383	3,660	2,723
April	5,032	2,397	2,635	4,999	2,343	2,656	6,350	3,606	2,744
May	4,930	2,358	2,572	5,339	2,659	2,680	6,759	3,907	2,852
June	4,960	2,306	2,654	5,442	2,765	2,677	7,242	4,366	2,876
July	5,103	2,370	2,733	5,426	2,711	2,715	7,563	4,706	2,857
August	5,393	2,564	2,829	5,967	3,004	2,963	8,138	5,146	2,992
September	5,638	2,788	2,850	5,859	2,936	2,923	8,361	5,295	3,066
October	5,752	2,916	2,836	5,727	2,927	2,800	8,335	5,305	3,030
November	5,747	2,933	2,814	5,914	3,008	2,906	8,503	5,381	3,122
December	5,997	3,036	2,961	5,968	2,976	2,992	8,474	5,321	3,153

r Revised.
[1] Monthly figures are seasonally adjusted and may not add to totals.
[2] "All other primary metals" obtained by subtracting blast furnace from primary metals figures.

Source: U.S. Department of Commerce, Office of Business Economics. Survey of Current Business. V. 49–53, No. 3, March 1969–73, pp. S–5, S–6, S–7.

Table 15.—Index of stocks of crude minerals at mines or in hands of primary producers at yearend

(1967 = 100)

Yearend	Metals and nonmetals [1]	Metals: Total	Metals: Iron ore	Metals: Other ferrous	Metals: Nonferrous	Nonmetals [1]
1968	121	120	123	119	100	123
1969	118	104	106	83	107	136
1970	131	113	118	93	99	154
1971	148	147	136	275	101	149
1972 p	142	143	113	428	78	141

p Preliminary.
1 Excludes fuels.

Table 16.—Index of stocks of mineral manufacturers, consumers, and dealers at yearend

(1967 = 100)

Yearend	Metals and nonmetals [1]	Metals: Total	Metals: Iron	Metals: Other ferrous	Metals: Base nonferrous	Metals: Other nonferrous	Nonmetals [1]
1968	96	96	95	109	105	78	102
1969	93	93	85	103	110	74	91
1970	106	106	93	113	126	93	101
1971	103	104	99	135	109	96	88
1972 p	95	93	85	135	101	87	121

p Preliminary.
1 Excludes fuels.

Table 17.—Physical stocks of mineral energy resources and related products at yearend

(Producers' stocks, unless otherwise indicated)

Fuels	1968	1969	1970	1971	1972 p
Coal and related products:[1]					
Bituminous coal and lignite [2] short tons	85,525,000	80,482,000	92,275,000	89,985,000	115,313,000
Coke do	5,985,025	3,120,000	4,113,000	3,510,000	2,914,000
Petroleum and related products:					
Carbon black thousand pounds	224,170	208,020	296,087	296,028	237,695
Crude petroleum and petroleum products thousand barrels	997,572	980,123	1,017,861	1,043,947	958,979
Crude petroleum do	272,193	265,227	276,367	259,648	246,395
Natural gas liquids do	(3)	(3)	(3)	(3)	(3)
Natural gasoline, plant condensates, and isopentane do	5,466	5,704	7,046	6,176	6,075
Gasoline do	211,526	217,392	214,348	223,771	217,149
Special naphthas do	5,829	6,292	6,193	5,384	5,232
Liquefied gases [4] do	76,160	59,602	67,043	94,713	85,717
Distillate fuel oil do	173,158	171,714	195,271	190,622	154,319
Residual fuel oil do	67,359	58,395	53,994	59,681	55,216
Petroleum asphalt do	20,055	16,753	15,779	21,202	21,636
Other products do	165,826	179,044	181,820	182,750	167,240
Natural gas [5] billion cubic feet	2,746	2,852	3,207	3,523	3,523

p Preliminary.
1 Series on anthracite stocks in ground storage has been discontinued.
2 Stocks at industrial, consumer, and retail yards and on upper lake docks.
3 Now distributed among petroleum products shown below.
4 Includes ethane.
5 American Gas Association.

Table 18.—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, and glass products	Primary metals: Blast furnace and steel mills	Primary metals: Other primary metals [1]	Primary metals: Total
1968: December	2,118	2,219	4,039	3,513	7,552
1969: December	2,274	2,483	4,312	3,740	8,052
1970: December	2,539	2,648	4,717	4,145	8,862
1971: December	2,433	2,263	4,800	4,395	9,195
1972:					
December	2,200	2,381	5,244	4,375	9,619
January	2,235	2,257	5,062	4,266	9,328
February	2,215	2,253	5,123	4,273	9,396
March	2,185	2,234	5,194	4,312	9,506
April	2,199	2,272	5,247	4,306	9,553
May	2,208	2,260	5,284	4,316	9,600
June	2,213	2,282	5,370	4,326	9,696
July	2,228	2,285	5,392	4,317	9,709
August	2,254	2,337	5,385	4,374	9,759
September	2,272	2,367	5,411	4,350	9,761
October	2,261	2,385	5,347	4,317	9,664
November	2,264	2,378	5,321	4,296	9,617

1 "Other primary metals" obtained by subtracting blast furnace from primary metals figures.
Source: U.S. Department of Commerce, Office of Business Economics. Survey of Current Business. V. 49–53, No. 3, March 1969–73, pp. S5–6.

Table 19.—Value of selected minerals and mineral products imported and exported by the United States in 1972, by commodity group, and commodity [1]

(Thousand dollars)

SITC code [2]		Exports	Imports
	Minerals, nonmetallic (crude):		
271	Fertilizers, crude	108,637	7,082
273	Stone, sand and gravel	18,646	27,899
274	Sulfur and unroasted iron pyrites	32,499	16,760
275	Natural abrasives (including industrial diamond)	39,624	54,540
276	Other crude minerals	144,973	191,365
	Total	344,379	297,646
	Metals (crude and scrap):		
281	Iron ore and concentrates	26,775	415,934
282	Iron and steel scrap	243,608	17,666
283	Ores and concentrates of nonferrous base metals	105,263	471,915
284	Nonferrous metal scrap	120,466	58,916
285	Platinum and platinum-group metal ores and concentrates	11,180	26,618
286	Uranium and thorium ores and concentrates	627	89
	Total [3]	507,920	991,138
	Mineral energy resources and related products:		
321	Coal, coke, and briquets (including peat)	1,019,116	22,609
331	Petroleum, crude and partly refined	2,651	2,592,607
332	Petroleum products, except chemicals	442,361	1,722,159
341	Gas, natural and manufactured	89,720	476,700
	Total [3]	1,553,847	4,814,075
	Chemicals:		
	Inorganic chemicals:		
513	Elements, oxides, and halogen salts	262,087	348,696
514	Other inorganic chemicals	152,054	74,082
515	Radioactive and associated materials except uranium and thorium	181,332	110,104
521	Mineral tar, crude chemicals from coal, petroleum, and natural gas	30,855	7,959
	Total	626,328	540,841
	Minerals, nonmetallic (manufactured):		
661	Lime, cement, and fabricated building material, except glass and clays	17,814	112,692
662	Clays and refractory construction materials	66,121	60,688
663	Mineral manufactures, not elsewhere specified	89,644	47,846
	Total	173,579	221,226
	Metals (manufactured):		
671	Pig iron, spiegeleisen, sponge iron, iron and steel powder and shot, and ferroalloys	26,213	184,684
672	Iron or steel ingots and other primary forms	52,093	38,351
673	Iron or steel bars, rods, angles, shapes, and sections	88,799	705,515
674	Iron or steel universals, plates, or sheets	183,780	1,397,474
675	Iron or steel hoops and strips	76,146	63,223
676	Iron or steel rails and railway track construction materials	20,447	6,406
677	Iron or steel wire (excluding wire rod)	16,409	142,206
678	Iron or steel tubes, pipes, and fittings	247,409	379,374
679	Iron or steel castings or forgings, unworked	114,565	14,396
681	Silver, platinum, and platinum-group metals	92,828	178,661
682	Copper and copper alloys	247,832	427,425
683	Nickel and nickel alloys	47,919	349,810
684	Aluminum and aluminum alloys	196,201	374,093
685	Lead and lead alloys	4,501	64,751
686	Zinc and zinc alloys	5,928	181,227
687	Tin and tin alloys	3,868	199,685
688	Uranium and thorium metals and alloys	291	(4)
689	Miscellaneous nonferrous base metals	60,562	73,558
	Total	1,485,791	4,780,839
	Grand Total	4,691,844	11,645,765

[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] Data may not add to totals shown because of independent rounding.
[4] Less than ½ unit.
Source: U.S. Department of Commerce, Bureau of the Census. U.S. Imports General and Consumption. FT 135, December 1972, table 1. U.S. Exports, Commodity and Country. FT 410, December 1972, table 1.

Table 20.—Percentage distribution of exports of selected minerals and mineral fuels and related products in 1972, by area of destination

SITC code [1]	Commodity	North America [2]	South America	Europe	Asia	Africa	Oceania	Soviet bloc [3]	Undesignated areas [4]
271	Fertilizers, crude	30	7	30	30	--	(5)	3	(5)
273	Stone, sand and gravel	81	3	7	3	1	1	--	4
274	Sulfur and unroasted iron pyrites	3	18	62	3	3	11	--	(5)
275	Natural abrasives, including industrial diamond	12	4	51	27	2	3	(5)	1
276	Crude minerals, not elsewhere specified	32	5	37	21	1	3	(5)	1
281	Iron ore and concentrates	75	--	(5)	25	--	--	--	(5)
282	Iron and steel scrap	20	8	25	47	(5)	(5)	--	(5)
283	Ores and concentrates of nonferrous base metal	12	2	62	24	(5)	(5)	(5)	(5)
284	Nonferrous metal scrap	17	1	35	47	(5)	--	(5)	(5)
286	Uranium and thorium ores and concentrates	100	--	--	--	--	--	--	--
321	Coke, coal, and briquets, including peat	29	6	31	34	--	(5)	(5)	(5)
331	Petroleum, crude and partly refined	29	2	17	51	--	--	--	1
332	Petroleum products, except chemicals	26	10	35	20	5	3	(5)	1
341	Gas, natural and manufactured	55	(5)	(5)	45	(5)	(5)	--	(5)
513	Inorganic chemical elements, oxides, and halogen salts	38	17	17	10	4	5	8	1
514	Other inorganic chemicals	31	12	35	13	3	4	(5)	2
515	Radioactive and associated materials	20	9	58	13	(5)	(5)	(5)	(5)
521	Mineral tar and crude chemicals from coal, petroleum, and natural gas	26	20	16	37	(5)	(5)	--	1
661	Lime, cement, and fabricated building materials except glass and clay	39	3	48	4	1	2	(5)	3
662	Clay and refractory construction materials	44	12	26	11	1	2	1	3
663	Mineral manufactures, not elsewhere specified	41	6	30	13	3	3	1	3
671	Pig iron, sponge iron, iron or steel powders or shot and ferroalloys	41	7	37	11	1	1	--	2
672	Iron and steel ingots and other primary forms	48	10	30	10	1	(5)	--	1
673	Iron and steel bars, rods, angles, shapes, and sections	51	12	15	17	2	(5)	1	2
674	Iron and steel plates and sheets	29	14	28	25	1	1	1	1
675	Iron and steel hoop and strip	30	21	40	4	2	2	(5)	1
676	Iron and steel rails and railway track construction materials	51	36	1	7	3	1	--	1
677	Iron and steel wire (except insulated electric)	46	12	24	9	3	3	--	3
678	Iron and steel tubes, pipes, and fittings	39	11	11	27	7	2	1	2
679	Iron and steel castings and forgings (rough)	84	3	8	3	1	1	(5)	(5)
681	Silver, platinum, and platinum-group metals	3	1	57	39	(5)	(5)	(5)	(5)
682	Copper and copper alloys	17	9	51	22	(5)	(5)	(5)	1
683	Nickel and nickel alloys	39	4	48	6	2	(5)	--	1
684	Aluminum and aluminum alloys	46	8	27	15	2	1	(5)	1
685	Lead and lead alloys	21	8	56	7	--	1	--	7
686	Zinc and zinc alloys	51	6	19	15	3	1	--	5
687	Tin and tin alloys	49	5	32	10	--	--	1	3
688	Uranium and thorium and their alloys	26	--	62	8	--	--	--	4
689	Base metals and alloys, not elsewhere specified	25	7	47	17	1	1	--	2

[1] Standard Industrial Trade Classification.
[2] Includes Trinidad and Netherlands Antilles.
[3] U.S.S.R., Bulgaria, East Germany, Albania, Czechoslovakia, Hungary, Poland, Romania, People's Republic of China, North Korea, North Vietnam, and Yugoslavia.
[4] Special category exports.
[5] Less than ½ unit.

Source: U.S. Department of Commerce, Bureau of the Census. U.S. Exports Schedule B, Commodity and Country. FT 410, December 1972, table 2.

Table 21.—Percentage distribution of imports of principal minerals and mineral fuels and related products in 1972, by area of origin

SITC code [1]	Commodity	North America	South America	Europe	Asia	Africa	Oceania	Soviet bloc [2]
2713000	Phosphates, crude and apatite	95	--	--	--	5	--	--
2732100	Gypsum	99	--	1	(3)	--	--	--
2743000	Sulfur	100	--	(3)	--	(3)	--	--
2752400	Natural abrasives	2	--	96	1	(3)	(3)	1
2762200	Graphite, natural	28	--	27	22	23	--	(3)
2762500	Magnesia, refractory and caustic-calcined, crude magnesite	2	--	85	7	--	1	5
2763000	Salt	91	6	2	(3)	1	--	--
2764000	Asbestos	96	(3)	(3)	--	4	--	(3)
2765200	Mica, including scrap	(3)	36	1	56	7	--	--
2765420	Fluorspar	67	(3)	29	--	4	--	--
2769300	Barite, crude	31	17	42	1	9	--	--
2769500	Talc	8	--	62	30	--	--	--
2810000	Iron ore and concentrates	60	31	1	(3)	6	2	--
2820000	Iron and steel scrap	89	--	11	(3)	(3)	(3)	--
2831100	Copper ores and concentrates	14	27	--	56	--	3	--
2833000	Bauxite	70	28	(3)	(3)	--	2	--
2834000	Lead ores and concentrates	44	24	(3)	--	(3)	32	--
2835000	Zinc ores and concentrates	86	5	3	--	5	1	--
2836000	Tin ores and concentrates	--	100	--	--	--	--	--
2837000	Manganese ores and concentrates	5	24	--	2	64	5	--
2839100	Chrome ores	--	--	11	15	23	--	51
2839200	Tungsten ores and concentrates	30	27	5	25	5	8	--
2839310	Tantalum, molybdenum, vanadium ores and concentrates	19	35	6	1	12	27	--
2839320, 2839330	Titanium ores and concentrates	23	--	(3)	(3)	--	77	--
2839340	Zirconium ore	1	(3)	(3)	(3)	5	94	--
2839910	Antimony ores and needles	9	28	1	1	61	(3)	--
2839920	Beryllium ores and concentrates	--	59	--	--	38	3	--
2839930	Columbium ores and concentrates	3	71	5	2	19	--	--
2840200	Copper waste and scrap	94	1	4	1	--	--	--
2840300	Nickel waste and scrap	50	--	34	1	14	1	--
2840400	Aluminum waste and scrap	88	1	11	--	(3)	--	--
2840500	Magnesium waste and scrap	17	--	72	5	5	1	--
2840600	Lead waste and scrap	89	--	11	--	--	--	--
2840700	Zinc waste and scrap	100	--	--	--	--	--	--
2840900	Tin waste and scrap	71	--	12	17	--	--	--
2850140, 2850240	Platinum-group metals, ores, concentrates, waste	30	4	51	(3)	7	8	--
2860000	Thorium ores and concentrates	--	--	--	100	--	--	--
3214000, 3218000, 3219000	Coal, coke, and briquets	92	--	1	(3)	6	1	--
3310000	Petroleum, crude and partly refined	43	20	(3)	19	18	(3)	(3)
3320000	Petroleum products, except chemicals	43	42	9	4	1	(3)	(1)
3410000	Gases, natural and manufactured	97	3	(3)	(3)	(3)	--	--
5132500	Mercury including waste and scrap	59	5	15	(3)	17	--	4
5136500	Alumina	29	21	6	5	(3)	39	--
5210000	Mineral tar and crude chemicals from coal, petroleum and natural gas	17	--	76	4	--	--	3
5613000	Potassic fertilizers and fertilizer materials	91	(3)	3	5	1	--	--

[1] Standard Industrial Trade Classification.
[2] U.S.S.R., Bulgaria, East Germany, Albania, Czechoslovakia, Hungary, Poland, Romania, Peoples' Republic of China, North Korea, North Vietnam, and Yugoslavia.
[3] Less than ½ unit.

Source: U.S. Department of Commerce, Bureau of the Census. U.S. Imports, FT 135, December 1972, table 2.

Table 22.—Consumption of major mineral products, mineral fuels, and electricity 1971, 1972, and projections

Commodity	1971	1972 p	2000
MINERAL PRODUCTS			
Ferrous metals:			
Iron ore ... thousand long tons	116,196	126,943	NA
Iron content ... million short tons	75	NA	153
Raw steel (production) ... thousand short tons	120,443	133,241	NA
Chromite ores (gross weight):			
Metallurgical grade ... do	720	727	NA
Refractory grade ... do	193	224	NA
Chemical grade ... do	180	189	NA
Manganese ore (35% or more Mn) ... do	2,155	2,331	3,900
Molybdenum (Mo content) ... thousand pounds	40,950	45,558	188,000
Tungsten (W content) ... do	11,622	14,107	76,400
Nonferrous metals:			
Aluminum (apparent consumption) ... thousand short tons	5,099	5,588	28,400
Antimony, primary ... short tons	13,707	16,124	48,000
Copper, refined ... thousand short tons	2,020	2,239	7,100
Lead, primary and secondary ... do	1,432	1,485	2,730
Zinc, all classes ... do	1,651	1,829	3,090
Mercury, primary ... 76-pound flasks	52,257	52,907	102,000
Platinum-group metals ... thousand troy ounces	1,266	1,560	3,157
Silver (industrial consumption) ... do	129,146	151,063	420,000
Ilmenite and titanium slag (estimated TiO_2 content) ... short tons	588,072	649,025	1,840,000
Uranium (U_3O_8, estimated purchases by private industry) ... do	12,800	11,600	73,113
Nonmetals:			
Asbestos (apparent consumption) ... thousand short tons	759	809	2,430
Cement (production) ... do	78	85	NA
Clays (apparent consumption) ... do	[1] 56,666	59,456	174,000
Lime (sold or used) ... do	19,591	20,290	NA
Phosphate rock (P_2O_5 content, apparent consumption) ... do	12,553	13,753	NA
Potash (K_2O content, apparent consumption) ... do	4,794	4,814	14,455
Salt (apparent consumption) ... do	47,262	47,618	158,900
Sand and gravel ... million short tons	920	913	3,200
Stone, crushed (sold or used) ... do	874	923	3,400
Sulfur, all forms (apparent consumption) ... thousand long tons	9,173	9,833	30,000
MINERAL ENERGY RESOURCES AND ELECTRICITY			
Bituminous coal ... million short tons	495	520	1,000
Coal carbonized for coke [2] ... do	(83)	(87)	(115)
Anthracite ... do	7	6	2
Petroleum production and natural gas liquids ... million barrels	5,553	5,990	14,500
Natural gas, dry [3] ... million cubic feet	22,132	22,429	49,000
Electricity generation, net ... million kilowatt hours	1,717,520	1,853,390	NA
Utilities ... do	1,613,936	1,747,323	[4] 9,010,000
Hydropower [5] ... do	269,851	280,285	[4] 700,000
Nuclear power ... do	37,899	54,031	[4] 5,470,000
Conventional fuel-burning plants ... do	1,309,716	1,420,558	[4] 2,840,000
Industrial ... do	103,585	106,067	NA
Total energy resources inputs ... trillion Btu	68,698	72,242	[4] 191,900

p Preliminary. NA Not available.
[1] Erroneously omitted in 1971 table.
[2] Figures in parentheses are not added to totals.
[3] Residue gas excludes extraction loss but includes transmission loss.
[4] Dupree, Walter G. Jr., and James A. West. U.S. Energy Through Year 2000. U.S. Department of the Interior. December 1972. Tables 1 and 8.
[5] Net generation adjusted for net imports or exports. The bulk of net trade is hydropower with an undetermined amount of steam plant power.

Table 23.—Electrical energy sales to ultimate consumers

(Million kilowatt hours)

Region	1968 Total consumption	1968 Residential	1968 Industrial and commercial	1969 Total consumption	1969 Residential	1969 Industrial and commercial
New England	47,386	16,970	28,946	51,373	18,789	31,040
Middle Atlantic	176,158	49,854	115,301	190,582	54,405	124,633
East North-Central	238,138	67,080	161,679	256,212	73,409	172,953
West North-Central	77,624	29,644	45,375	84,125	32,436	48,909
South Atlantic	180,463	63,790	109,589	199,257	72,253	118,360
East South-Central	122,608	36,033	84,770	129,601	39,331	88,308
West South-Central	126,160	37,070	83,202	141,610	43,068	92,037
Mountain	53,157	14,164	36,513	59,067	15,700	40,638
Pacific	176,682	51,640	116,230	190,979	56,940	124,373
Alaska and Hawaii	3,945	1,447	2,380	4,372	1,591	2,655
Total United States	1,202,321	367,692	783,985	1,307,178	407,922	843,906
	1970			1971		
New England	55,255	20,900	32,804	59,072	22,870	34,645
Middle Atlantic	201,230	59,709	129,328	208,567	62,878	133,086
East North-Central	267,228	79,687	177,306	281,393	84,629	186,011
West North-Central	90,414	35,339	52,109	94,872	37,372	54,395
South Atlantic	218,715	81,493	128,261	234,920	87,559	137,798
East South-Central	136,728	43,788	90,760	142,057	45,905	93,823
West South-Central	154,136	47,997	99,380	164,047	51,497	105,361
Mountain	62,592	16,977	42,654	66,168	18,641	44,427
Pacific	200,260	60,171	129,739	209,980	65,814	133,615
Alaska and Hawaii	4,801	1,734	2,931	5,365	1,915	3,291
Total United States	1,391,359	447,795	885,272	1,466,441	479,080	926,452

Source: Edison Electric Institute. Statistical Yearbook of the Electric Utility Industry, 1968–1971.

Table 24.—Total employment in selected mineral industries

(Thousands)

	1968	1969	1970	1971	1972
MINING					
Metals:					
Iron ores	25.3	25.6	26.2	24.5	20.1
Copper ores	28.1	33.7	37.0	34.7	38.9
Total [1]	82.0	89.4	94.8	89.0	86.1
Nonmetal mining and quarrying	116.2	115.6	116.0	113.0	112.1
Fuels:					
Bituminous	126.4	129.5	138.8	132.3	143.2
Other coal	5.8	5.7	5.6	5.4	3.7
Crude petroleum and natural gasfields	148.1	145.0	141.7	141.0	137.8
Oil and gasfield services	127.5	133.9	125.2	120.3	124.1
Total	407.8	414.1	411.3	399.0	408.8
Total mining	606.0	r 619.0	622.1	601.0	607.0
MANUFACTURING					
Minerals:					
Fertilizers, complete and mixing only	39.7	39.6	40.5	38.2	35.8
Cement, hydraulic	34.7	34.9	34.1	32.0	33.6
Blast furnaces, steel works, and rolling mills	555.5	561.1	549.6	506.3	492.2
Nonferrous smelting and refining	78.1	86.2	86.3	83.9	83.6
Total	708.0	721.8	710.5	660.4	645.2
Fuels:					
Petroleum refining	150.1	144.7	153.4	153.1	150.8
Other petroleum and coal products	36.7	38.2	38.5	36.7	38.8
Total [2]	186.8	182.9	191.9	189.8	189.6
Total manufacturing	894.8	904.7	902.4	850.2	834.8

r Revised.
[1] Includes other metal mining not shown separately.
[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, United States, 1909–1970, Bull. 1312–7, 602 pages. Employment and Earnings, v. 17, No. 9, March 1971, v. 18, No. 9, March 1972, and v. 19, No. 9, March 1973, table B-2.

Table 25.—Average hours and gross earnings of production and related workers in the mineral and mineral fuels industries

	1968	1969	1970	1971	1972
MINING					
Metal:					
Iron ores:					
Weekly earnings	$144.70	$153.18	$162.99	$169.70	$185.40
Weekly hours	41.7	41.4	41.9	40.5	41.2
Hourly earnings	$3.47	$3.70	$3.89	$4.19	$4.50
Copper ores:					
Weekly earnings	$161.68	$169.00	$175.67	$178.67	$192.19
Weekly hours	47.0	46.3	44.7	42.9	41.6
Hourly earnings	$3.44	$3.65	$3.93	$4.16	$4.62
All metal mining: [1]					
Weekly earnings	$148.09	$157.32	$165.68	$171.39	$185.51
Weekly hours	43.3	43.1	42.7	41.6	41.5
Hourly earnings	$3.42	$3.65	$3.88	$4.12	$4.47
Nonmetallic mining and quarrying:					
Weekly earnings	$136.50	$149.11	$155.56	$165.23	$176.96
Weekly hours	44.9	45.6	44.7	44.9	44.8
Hourly earnings	$3.04	$3.27	$3.48	$3.68	$3.95
Fuels:					
All coal mining:					
Weekly earnings	$153.20	$166.74	$183.96	$194.00	$215.83
Weekly hours	40.0	39.7	40.7	40.6	[2] 41.0
Hourly earnings	$3.83	$4.20	$4.52	[2] $4.79	[2] $5.30
Bituminous coal:					
Weekly earnings	$155.17	$169.18	$186.46	$196.02	$217.46
Weekly hours	40.2	39.9	40.8	[2] 40.6	[2] 41.0
Hourly earnings	$3.86	$4.24	$4.57	[2] $4.85	[2] $5.34
Crude petroleum and natural gas:					
Weekly earnings	$137.97	$147.19	$155.88	$159.75	$169.92
Weekly hours	40.7	41.0	40.7	42.6	42.8
Hourly earnings	$3.39	$3.59	$3.83	$3.75	$3.97
All fuels: [3]					
Weekly earnings	$143.59	$156.55	$166.35	$173.59	$191.27
Weekly hours	41.7	42.2	42.1	41.8	41.8
Hourly earnings	$3.46	$3.73	$3.97	$4.22	$4.53
All mining: [3]					
Weekly earnings	$141.20	$152.67	$160.07	[4] $167.89	$180.61
Weekly hours	44.3	44.6	43.8	[4] 43.5	43.4
Hourly earnings	$3.20	$3.43	$3.66	[4] $3.87	$4.17
MANUFACTURING					
Fertilizers, complete and mixing only:					
Weekly earnings	$108.54	$116.14	$123.68	$132.71	$143.14
Weekly hours	42.4	42.7	42.5	42.4	42.6
Hourly earnings	$2.56	$2.72	$2.91	$3.13	$3.36
Cement, hydraulic:					
Weekly earnings	$144.35	$155.87	$176.81	$194.37	$215.04
Weekly hours	41.6	41.9	41.8	41.8	42.0
Hourly earnings	$3.47	$3.72	$4.23	$4.65	$5.12
Blast furnaces, steel and rolling mills:					
Weekly earnings	$155.86	$168.51	$168.38	$181.43	$210.12
Weekly hours	40.8	41.2	39.9	39.7	40.8
Hourly earnings	$3.82	$4.09	$4.22	$4.57	$5.15
Nonferrous smelting and refining:					
Weekly earnings	$144.08	$152.64	$157.63	$166.83	$185.59
Weekly hours	42.5	42.4	41.7	41.5	41.8
Hourly earnings	$3.39	$3.60	$3.78	$4.02	$4.44
Petroleum refining and related industries:					
Weekly earnings	$159.38	$170.40	$182.33	$194.19	$208.89
Weekly hours	42.5	42.6	42.7	42.4	42.2
Hourly earnings	$3.75	$4.00	$4.27	$4.58	$4.95
Petroleum refining:					
Weekly earnings	$166.27	$178.08	$189.93	$202.44	$219.45
Weekly hours	42.2	42.1	42.3	42.0	41.8
Hourly earnings	$3.94	$4.23	$4.49	$4.82	$5.25
Other petroleum and coal products:					
Weekly earnings	$135.91	$147.52	$157.52	$166.44	$175.34
Weekly hours	43.7	44.3	44.0	43.8	43.4
Hourly earnings	$3.11	$3.33	$3.58	$3.80	$4.04
All manufacturing: [3]					
Weekly earnings	$153.68	$165.47	$168.76	[4] $181.46	$206.52
Weekly hours	41.3	41.7	40.5	[4] 40.4	41.1
Hourly earnings	$3.73	$3.99	$4.16	$4.49	$5.02

[1] Includes other metal mining not shown.
[2] 11-month average.
[3] Weighted average of data computed using figures for production workers as weights.
[4] Corrected figure; erroneously reported in 1971.

Source: U.S. Department of Labor, Bureau of Labor Statistics. Employment and Earnings, United States, 1909–70, Bull. 1312–7, September 1971, 602 pp. Employment and Earnings. V. 17, No. 9, March 1971; v. 18, No. 9, March 1972; and v. 19, No. 9, March 1973, table C–2.

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:										
1970	40	21	27	26	38	31	37	23	16	21
1971	39	20	35	23	29	23	28	18	13	19
1972	44	16	31	25	34	29	32	18	13	18
Total separation rate:										
1970	48	32	33	30	37	36	29	26	18	16
1971	42	19	46	31	33	31	28	20	16	17
1972	42	16	22	25	35	33	27	20	16	19
Layoff rate:										
1970	18	16	12	5	6	15	1	7	5	2
1971	16	7	30	11	7	14	4	6	5	3
1972	11	5	8	5	8	18	2	6	5	6

[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. 17, No. 9, March 1971; v. 18, No. 9, March 1972; and v. 19, No. 9, March 1973, table D-2.

Table 27.—Wages, salaries, and average annual earnings in the United States

	1970 [r]	1971	1972 [p]	% change 1970–71	% change 1971–72
Wages and salaries:					
All industries, total ... millions	$541,976	$573,832	$627,334	+5.9	+9.3
Mining ... do	5,824	6,049	6,706	+3.9	+10.9
Manufacturing ... do	158,294	160,640	175,776	+1.5	+9.4
Average earnings per full-time employee:					
All industries, total	7,571	8,065	8,604	+6.5	+6.7
Mining	9,294	9,924	10,320	+6.8	+4.0
Manufacturing	8,153	8,640	9,232	+6.0	+6.9

[p] Preliminary. [r] Revised.

Source: U.S. Department of Commerce, Office of Business Economics. Survey of Current Business. V. 52, No. 7, July 1973, tables 6.2 and 6.5.

Table 28.—Labor productivity indexes for selected minerals

(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
1967	100.0	100.0	100.0	100.0	100.0	100.0
1968	121.1	119.8	109.6	108.2	109.2	110.0
1969	r 133.1	125.2	116.2	r 113.4	r 116.2	r 117.8
1970	140.3	131.9	126.9	114.3	117.1	117.3
1971 p	136.8	133.5	133.8	112.6	115.3	119.6
	Copper, recoverable metal mined per—			Iron, usable ore mined per—		
	Employee	Production worker	Production worker man-hour	Employee	Production worker	Production worker man-hour
1967	100.0	100.0	100.0	100.0	100.0	100.0
1968	114.3	113.1	103.4	103.4	104.4	105.1
1969	r 122.4	115.1	106.9	r 105.4	r 108.0	r 109.6
1970	124.7	117.2	112.8	105.2	107.8	108.0
1971 p	117.5	114.7	114.9	102.5	105.0	108.9
	Petroleum, refined per [1]—			Bituminous coal and lignite mined per [1]—		
	Employee	Production worker	Production worker man-hour	Employee	Production worker	Production worker man-hour
1967	100.0	100.0	100.0	100.0	100.0	100.0
1968	103.8	104.5	103.7	103.1	103.9	105.1
1969	r 110.7	r 113.1	r 110.6	r 103.3	r 103.9	r 105.4
1970	107.6	109.0	110.2	103.7	104.0	103.8
1971 p	111.6	113.0	114.9	99.0	102.2	102.5

p Preliminary. r Revised.
[1] Figures for petroleum and bituminous coal were reversed in 1971 Yearbook.

Source: U. S. Department of Labor, Bureau of Labor Statistics. Index of Output per Man-hour Selected Industries, 1972 edition. BLS Bull. 1758, 1972, tables 2, 4, 6, 8, 12, and 42.

Table 29.—Index of average unit value of minerals produced 1968-1972

(1967 = 100)

	1968	1969	1970	1971	1972 p
METALS					
Ferrous	102.0	104.1	109.4	115.9	120.2
Nonferrous:					
Base	106.5	120.0	141.9	129.9	130.7
Monetary	125.2	118.0	109.1	108.8	138.1
Other	100.8	95.4	129.1	130.0	131.1
Average	107.3	115.3	136.4	127.8	131.5
Average all metals	104.5	109.4	122.1	121.5	125.5
NONMETALS					
Construction	101.5	103.5	107.8	112.7	118.0
Chemical	102.9	97.9	r 87.2	86.2	85.3
Other	103.3	111.2	108.5	115.7	121.4
Average	101.9	102.6	103.2	106.9	110.8
FUELS					
Coal	101.3	108.0	135.4	152.9	162.5
Crude oil and natural gas	101.4	107.9	108.5	115.6	116.2
Average	100.4	106.1	111.8	120.6	122.7
Overall average	101.1	105.6	r 110.7	117.6	120.3

p Preliminary. r Revised.

Table 30.—Index of implicit unit value of minerals produced

(1967 = 100)

	1968	1969	1970	1971	1972 p
METALS					
Ferrous	101.9	104.1	109.1	115.6	119.4
Nonferrous:					
Base	106.7	120.4	143.4	130.1	130.5
Monetary	125.1	118.0	109.5	109.9	136.2
Other	100.4	95.6	129.7	132.0	136.4
Average	107.2	117.7	139.8	128.7	131.4
Average all metals	105.0	112.4	128.7	124.1	127.3
NONMETALS					
Construction	101.0	103.0	107.7	112.8	117.8
Chemical	102.4	97.8	87.4	86.9	84.8
Other	97.5	111.0	108.8	115.2	121.2
Average	101.4	102.3	103.2	107.3	110.8
FUELS					
Coal	101.2	108.0	135.4	152.9	162.7
Crude oil and natural gas	101.4	107.9	108.5	115.5	116.2
Average	100.4	106.0	111.5	119.8	122.3
Overall average	101.1	105.9	111.8	117.6	120.2

p Preliminary.

Table 31.—Price indexes for selected metals, minerals, and fuels

(1967 = 100)

Commodity	Annual average 1971	Annual average 1972	% change from 1971
Metals and metal products	119.0	123.5	+3.8
Iron and steel	121.8	128.4	+5.4
Iron ore	103.0	103.0	--
Iron and steel scrap	114.6	121.8	+6.3
Semifinished steel products	122.7	130.9	+6.7
Finished steel products	123.0	130.4	+6.0
Foundry and forge shop products	119.2	124.3	+4.3
Pig iron and ferroalloys	126.3	125.4	−.7
Nonferrous metals	116.0	116.9	+.8
Primary metal refinery shapes	117.5	115.6	−1.6
Aluminum ingot	[1] 116.2	96.9	−16.6
Lead, pig, common	99.0	109.6	+10.7
Zinc, slab, prime western	112.2	123.4	+10.0
Nonferrous scrap	103.6	103.3	−.3
Nonmetallic mineral products	122.4	126.1	+3.0
Concrete ingredients	121.9	126.9	+4.1
Sand, gravel, and crushed stone	119.1	121.7	+2.2
Structural clay products	114.2	117.3	+2.7
Gypsum products	106.8	114.7	+7.4
Other nonmetallic minerals	124.1	127.0	+2.3
Building lime	118.5	121.9	+2.9
Insulation materials	131.7	136.9	+3.9
Bituminous binders	121.8	123.9	+1.7
Fertilizer materials	75.9	74.4	−2.0
Nitrogenates	71.7	72.0	+.4
Phosphates	78.7	75.0	−4.7
Phosphate rock	79.8	79.8	--
Potash	100.4	100.4	--
Muriate, domestic	99.8	99.7	−.1
Sulfate	103.3	104.1	+.8
Fuels and related products and power	114.2	118.6	+3.9
Coal	181.8	193.8	+6.6
Anthracite	145.0	151.1	+4.2
Bituminous	184.9	197.4	+6.8
Coke	148.7	155.5	+4.6
Gas fuels	108.0	114.1	+5.6
Electric power	113.6	121.5	+7.0
Petroleum products, refined	106.8	108.9	+2.0
Crude petroleum	113.2	113.8	+.5
All commodities other than farm and food	114.0	117.9	+3.4
All commodities	113.9	119.1	+4.6

[1] Corrected figure; erroneously reported in 1971.

Source: U.S. Department of Labor, Bureau of Labor Statistics. Wholesale Prices and Price Indexes. January–December 1972, table 6; January 1973, table 4.

Table 32.—Comparative mineral energy resource prices

Fuel		1970	1971	1972
Bituminous coal average prices, cost of coal at merchant coke ovens	dollars per net ton	12.28	15.32	17.67
Anthracite, average sales realization per net ton at preparation plants, excluding dredge coal:				
Chestnut	dollars	15.67	16.79	17.66
Pea	do	13.87	15.28	15.72
Buckwheat, No. 1	do	13.26	14.83	15.38
Petroleum and petroleum products:				
Crude petroleum, average price per barrel at well	do	3.18	3.39	3.39
Gasoline, average dealers' net price (excluding taxes) of gasoline in 55 U.S. cities [1]	cents per gallon	17.68	18.11	17.72
Residual fuel oil:				
No. 6 fuel, maximum 1% sulfur, at Philadelphia [1]	dollars per barrel (refinery)	3.16	4.21	4.05
Bunker C, average price for all Gulf ports [1]	do	2.44	2.81	2.05
Distillate fuel oil:				
No. 2 distillate, average of high and low prices at Philadelphia [1]	cents per gallon (refinery)	11.08	11.78	11.75
No. 2 distillate, average price for all Gulf ports [1]	do	9.41	9.80	10.10
Natural gas:				
Average U.S. value at well	cents per thousand cubic feet	17.1	18.2	18.6
Average U.S. value at point of consumption	do	53.6	57.7	62.1

[1] Platt's Oil Price Handbook.

Table 33.—Cost of fuel in steam-electrical power generation

(Cents per million Btu)

Area	1969			1970			1971		
	Coal	Oil	Gas	Coal	Oil	Gas	Coal	Oil	Gas
New England	36.9	28.3	33.7	41.9	32.8	35.3	48.8	47.6	45.5
Middle Atlantic	30.0	33.6	35.6	36.1	40.2	38.3	40.9	57.1	44.9
East North-Central	26.4	62.0	31.6	30.4	56.7	37.1	35.5	63.2	42.9
West North-Central	26.2	51.8	24.9	28.2	59.0	25.6	31.6	70.3	28.3
South Atlantic	28.4	30.4	31.6	36.1	31.9	34.7	41.8	43.3	39.7
East South-Central	21.1	51.1	24.3	23.6	54.1	25.3	29.2	49.6	27.9
West South-Central	31.1	36.9	20.5	40.1	44.6	21.1	17.8	59.8	22.2
Mountain	20.6	27.3	27.3	19.8	28.2	29.3	20.9	40.4	32.4
Pacific	--	34.5	31.2	--	36.8	32.4	--	55.4	34.6
United States	26.6	31.9	25.4	31.1	36.6	27.0	36.0	51.5	28.8

Source: National Coal Association. Steam-Electric Plant Factors. 1970 through 1972, table 2.

Table 34.—Cost of electrical energy

(Cents per kilowatt hour)

Area	1969			1970			1971		
	Total	Residential	Commercial and industrial	Total	Residential	Commercial and industrial	Total	Residential	Commercial and industrial
New England	2.2	2.6	1.8	2.2	2.6	1.9	2.3	2.7	2.0
Middle Atlantic	1.8	2.5	1.5	1.9	2.6	1.6	2.2	2.9	1.9
East North-Central	1.6	2.3	1.4	1.7	2.3	1.4	1.8	2.4	1.5
West North-Central	1.9	2.4	1.6	2.0	2.4	1.7	2.0	2.5	1.7
South Atlantic	1.5	1.9	1.3	1.6	1.9	1.3	1.6	2.0	1.4
East South-Central	1.0	1.3	.8	1.0	1.4	.9	1.2	1.5	1.0
West South-Central	1.5	2.2	1.2	1.5	2.1	1.2	1.5	2.1	1.2
Mountain	1.5	2.1	1.2	1.5	2.1	1.2	1.5	2.1	1.3
Pacific	1.2	1.6	1.0	1.2	1.7	1.1	1.3	1.7	1.1
Alaska and Hawaii	2.4	2.8	2.1	2.4	2.8	2.1	2.5	2.9	2.2
United States	1.5	2.1	1.3	1.6	2.1	1.3	1.7	2.2	1.4

Source: Edison Electric Institute. Statistical Yearbook of the Electric Utilities Industry. 1969 through 1971. Based on tables 22–S and 36–S.

Table 35.—Price index of principal metal mining expenses [1]

(1967 = 100)

Year	Total	Labor	Supplies	Fuel	Electrical energy
1968	101.4	101.0	102.4	98.8	100.8
1969	104.2	103.5	106.1	101.0	102.0
1970	r 108.5	r 107.7	110.5	105.9	104.8
1971	114.1	113.0	115.7	114.2	113.6
1972 p	119.9	119.7	120.1	118.6	121.5

p Preliminary. r Revised.

[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 36.—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
1968	102	101
1969	108	105
1970	123	108
1971	138	NA
1972	NA	NA

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 37.—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				
1968	100.1	102.0	101.9	100.5
1969	102.3	104.8	108.9	105.2
1970	r 108.5	106.9	131.6	106.8
1971	114.8	111.1	151.5	NA
1972 p	112.3	127.8	NA	NA
INDEX OF VALUE OF PRODUCT PER MAN-PERIOD				
1968	105.1	113.0	102.1	105.3
1969	109.6	135.3	112.1	113.9
1970	110.5	170.1	133.2	123.9
1971	115.1	154.8	143.8	NA
1972 p	128.4	147.1	NA	NA
INDEX OF LABOR COSTS PER DOLLAR OF PRODUCT				
1968	100.1	93.4	100.8	99.2
1969	102.3	82.8	100.9	99.2
1970	106.7	70.9	91.7	98.5
1971	110.3	82.4	99.0	NA
1972 p	106.2	96.3	NA	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.

Table 38.—Price indexes for selected cost items in mineral fuels production

(1967=100)

Commodity	1972		Change from January (%)	Annual average		Change from 1971 (%)
	January	December		1971	1972	
Coal	192.7	205.5	+6.6	181.8	193.8	+6.6
Coke	150.5	159.9	+6.2	148.7	155.5	+4.6
Gas fuels	110.0	119.2	+8.4	108.0	114.1	+5.6
Petroleum products, refined	106.1	112.0	+5.6	106.8	108.9	+2.0
Industrial chemicals	101.4	101.0	−.4	102.0	101.2	−.8
Lumber	146.9	167.9	+14.3	135.5	159.4	+17.6
Explosives	113.3	132.1	+16.6	r 113.3	115.2	+1.7
Construction machinery and equipment	124.3	126.3	+1.6	121.4	125.7	+3.5

r Revised.

Source: U.S. Department of Labor Statistics. Wholesale Prices and Price Indexes, January 1973. Supplement 1972, February 1973, table 5; Supplement 1973, June 1973, table 5.

Table 39.—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, draglines, shovels, etc.	Specialized construction machinery	Portable air compressors	Scrapers and graders	Mixers, pavers, spreaders, etc.	Tractors other than farm
1968	105.7	103.4	106.4	104.9	105.2	97.0	105.3	104.4	106.8
1969	110.4	106.6	112.7	109.0	110.2	91.8	110.1	109.1	112.5
1970	115.5	110.5	118.4	114.0	117.4	93.7	115.2	116.0	116.7
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

Source: U.S. Department of Labor, Bureau of Labor Statistics. Wholesale Prices and Price Indexes, January 1969–71, table 2–A; January–December, 1972, table 6.

Table 40.—National income originated in the mineral industries

Industry	Income (million dollars) 1970 r	1971	1972 p	Change from 1971 (%)
Mining	7,672	7,010	8,246	+17.6
Metal mining	1,177	970	1,035	+6.7
Coal mining	2,157	2,052	2,375	+15.7
Crude petroleum and natural gas	3,048	2,571	3,279	+27.5
Mining and quarrying of nonmetallic minerals	1,300	1,419	1,557	+9.7
Manufacturing	217,505	226,363	252,589	+11.6
Chemicals and allied products	16,342	16,827	18,236	+8.4
Petroleum refining and related industries	7,342	7,917	8,634	+9.1
Stone, clay, and glass products	6,894	7,517	8,533	+13.5
Primary metal industries	15,961	15,325	17,404	+13.6
All industries	800,462	859,449	941,792	+9.6

p Preliminary. r Revised.

Source: U. S. Department of Commerce, Office of Business Economics. Survey of Current Business. V. 53, No. 7, July 1973, table 1, 12.

Table 41.—Annual average profit rates on shareholders' equity, after taxes, and total dividends, selected mineral manufacturing corporations

Industry	Annual profit rate (%) 1971	1972	Change from 1971	Total dividends (million dollars) 1971	1972	Change from 1971 (%)
All manufacturing [1]	9.7	10.6	+0.9	r 15,252	16,133	+5.8
Primary metals	4.8	6.0	+1.2	976	840	−13.9
Primary iron and steel	4.5	6.1	+1.6	469	470	+.2
Primary nonferrous metals	5.1	5.9	+.8	508	370	−27.2
Stone, clay, and glass products	9.1	10.1	+1.0	358	415	+15.9
Chemicals and allied products	11.8	12.9	+1.1	2,003	2,126	+6.1
Petroleum refining and related industries	10.3	8.7	−1.6	3,267	3,325	+1.8
Petroleum refining	10.3	8.6	−1.7	3,258	3,318	+1.8

r Revised.
[1] Except newspapers.

Source: Federal Trade Commission, Securities and Exchange Commission. Quarterly Financial Report for Manufacturing Corporations, 1st Quarter and 4th Quarter, 1972, tables 4 and 8.

Table 42.—Industrial and commercial failures and liabilities in mining and manufacturing

Industry	1970	1971	1972
Mining: [1]			
Number of failures	54	38	44
Current liabilities thousands	$59,046	$15,463	$11,907
Manufacturing:			
Number of failures	1,981	1,894	1,532
Current liabilities thousands	$758,795	$697,148	$755,084
All industrial and commercial industries:			
Number of failures	10,748	10,326	9,566
Current liabilities thousands	$1,887,754	$1,916,929	$2,000,244

[1] Including fuels.

Source: Dun and Bradstreet, Inc., Business Economics Department. Monthly Failure Report, K-13, No. 12, Jan. 21, 1972, 4 pp.; K-15, No. 12, Jan. 30, 1973, 4 pp.

Table 43.—Expenditures for new plant and equipment by firms in mining and selected mineral manufacturing industries

(Billion dollars)

Industry	1970	1971	1972
Mining [1]	1.89	2.16	2.42
Manufacturing:			
Primary iron and steel	1.68	1.37	1.24
Primary nonferrous metals	1.24	1.08	1.18
Stone, clay, and glass products	.99	.85	1.20
Chemical and allied products	3.44	3.44	3.45
Petroleum and coal products	5.62	5.85	5.25
All manufacturing	31.95	29.99	31.35

[1] Including fuels.

Source: U.S. Department of Commerce, Office of Business Economics. Survey of Current Business. V. 52, No. 3., March 1972, p. 20, table 8; v. 53, No. 3, March 1973, p. 20, table 9.

Table 44.—Plant and equipment expenditures of foreign affiliates of U.S. companies by area and industry

(Million dollars)

Area and country	1970			1971			1972 [1]		
	Mining and smelting	Petroleum	Manufacturing	Mining and smelting	Petroleum	Manufacturing	Mining and smelting	Petroleum	Manufacturing
Canada	r 411	726	1,159	696	746	1,110	645	825	1,061
Latin America	477	514	669	244	638	698	230	575	890
Europe	r 15	974	3,614	16	1,322	3,846	18	1,484	4,427
All other areas	r 484	r 1,582	1,081	779	2,022	1,098	764	2,296	1,264
Total [2]	r 1,387	r 3,797	6,524	1,735	4,728	6,751	1,657	5,180	7,642

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

Source: U.S. Department of Commerce, Office of Business Economics. Survey of Current Business. V. 52, No. 9, September 1972, pp. 20–21.

Table 45.—Estimated gross proceeds of new corporate securities offered for cash in 1972 [1]

Type of security	Total corporate		Manufacturing		Extractive [2]	
	Million dollars	%	Million dollars	%	Million dollars	%
Bonds	28,896	68.9	4,821	72.7	706	35.1
Preferred stock	3,367	8.0	202	3.1	3	.2
Common stock	9,694	23.1	1,607	24.2	1,301	64.7
Total	41,957	100.0	[3] 6,629	100.0	2,010	100.0

[1] Substantially all new issues of securities offered for cash sale in the Uuited 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 may not add to total shown because of independent rounding.

Source: U.S. Securities and Exchange Commission. Statistical Bulletin. V. 32, No. 7, Mar. 28, 1973, pp. 241–242.

Table 46.—Direct private investment of U.S. companies in foreign petroleum industries in 1971 p

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

	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	11,723	956	266	12,954	53,146	2,824	2,375	58,346
Canada	4,807	69	252	5,134	22,790	226	1,046	24,030
Europe	5,466	781	−61	6,202	24,516	2,083	1,009	27,621
Japan	540	78	24	637	1,483	211	125	1,818
Australia, New Zealand, South Africa, Republic of	910	28	52	981	4,356	304	196	4,876
Developing countries	8,333	718	135	9,163	21,448	1,397	546	23,337
Latin American Republics and other Western Hemisphere	3,938	200	66	4,194	14,760	668	373	15,763
Other Africa	1,914	115	72	2,095	2,614	174	98	2,869
Middle East	1,442	48	−20	1,465	1,617	54	−9	1,657
Other Asia and Pacific	1,039	355	16	1,410	2,457	501	85	3,048
International, unallocated	1,658	265	216	2,140	3,586	543	195	4,318
Total [1]	21,714	1,940	616	24,258	78,178	4,765	3,116	86,001

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

Source: U.S. Department of Commerce, Office of Business Economics. Survey of Current Business. V. 52, No. 11, November 1972, pp. 28, 29, 30.

Table 47.—Direct private investments of the United States in foreign mining and smelting industries in 1971 p

(Million dollars)

	Book value at yearend	Net capital outflows	Undistributed earnings of subsidiaries	Earnings [1]	Income [2]
Developed countries	4,060	385	47	294	247
Canada	3,265	271	35	206	170
Europe	78	9	−2	2	--
Japan	--	--	--	--	--
Australia, New Zealand, South Africa, Republic of	718	105	15	86	74
Australia	602	95	13	59	53
South Africa, Republic of	108	10	2	27	21
Developing countries	2,659	136	−21	210	236
Latin American Republics, total	1,356	−1	−40	73	112
Mexico	126	−12	−27	7	28
Panama	19	--	--	--	--
Brazil	119	(3)	(3)	(3)	(3)
Chile	452	−3	(4)	3	7
Peru	415	−6	--	25	24
Other Western Hemisphere	760	58	--	103	108
Other Africa	386	19	17	32	15
Middle East	3	--	--	--	--
Other Asia and Pacific	155	59	(4)	2	2
Total [5]	6,720	519	26	504	484

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] Combined in "Other industries" in source reference.
[4] Less than ½ unit.
[5] Data may not add to totals shown because of independent rounding.

Source: U.S. Department of Commerce, Office of Business Economics. Survey of Current Business. V. 52, No. 11, November 1972, p. 28.

Table 48.—Value of foreign direct investments in the United States

(Million dollars)

Industry	1967	1968	1969	1970	1971 p
Total	9,923	10,815	11,818	13,270	13,704
Petroleum	1,885	2,261	2,493	2,992	3,113

p Preliminary.

Source: U.S. Department of Commerce, Bureau of Economic Analysis. Survey of Current Business. V. 53, No. 2, February 1973, p. 30, table 1.

Table 49.—Railroad and water transportation of selected minerals and mineral energy products in the United States

(Thousand short tons)

Products	Rail [1] 1970	Rail [1] 1971	Rail [1] Change from 1970 (%)	Water [2] 1970	Water [2] 1971	Water [2] Change from 1970 (%)
Metals and minerals except fuels:						
Iron ore and concentrates	104,208	91,267	−12.4	75,175	68,042	−9.5
Iron and steel scrap	28,183	26,609	−5.6	1,812	1,505	−16.9
Pig iron	4,628	3,534	−23.6	422	395	−6.4
Iron and steel ingots, plates, rods, bars, tubing, and other primary products	48,907	42,356	−13.4	9,356	8,291	−11.4
Bauxite and other aluminum ores and concentrates	4,473	4,553	+1.8	893	396	−55.7
Other nonferrous ores and concentrates	17,977	14,584	−18.9	1,604	2,181	+36.0
Nonferrous metals and alloys	9,857	9,619	−2.4	627	651	+3.8
Nonferrous metal scrap	2,426	2,305	−5.0	43	93	+116.3
Slag	1,508	2,232	+48.0	385	751	+95.1
Sand and gravel	52,305	50,156	−4.1	73,946	82,649	+11.8
Stone, crushed and broken	61,794	57,273	−7.3			
Limestone flux and calcareous stone	--	--	--	34,115	30,819	−9.7
Cement, building	21,120	20,781	−1.6	10,735	10,793	+.1
Lime	6,346	6,094	−4.0	671	749	+11.6
Phosphate rock	31,926	33,267	+4.2	5,830	7,209	+23.7
Clays, ceramic and refractory materials	3,002	2,961	−1.4	2,086	1,757	−15.8
Sulfur, dry	3,147	2,883	−8.4	84	44	−47.6
Sulfur, liquid				8,368	8,300	−.8
Gypsum and plaster rock	553	648	+17.2	662	864	+30.5
Other nonmetallic minerals except fuels	10,622	10,647	+.2	7,335	7,692	+4.9
Fertilizer and fertilizer materials	19,503	19,134	−1.9	6,048	6,538	+8.1
Total	432,485	400,902	−7.3	240,197	239,719	−.2
Mineral energy resources and related products:						
Coal:						
Anthracite	5,792	5,601	−3.3	154,142	140,053	−9.1
Bituminous and lignite	398,830	354,954	−11.0			
Coke	1,547	1,528	−1.2	965	1,034	+7.2
Crude petroleum	502	457	−9.0	116,301	114,721	−1.4
Gasoline	2,051	1,660	−19.1	88,700	93,514	+5.4
Jet fuel				12,930	13,682	+5.8
Kerosine	160	132	−17.5	7,222	5,963	−17.4
Distillate fuel oil	1,461	1,316	−9.9	76,286	78,216	+2.5
Residual fuel oil	4,664	4,797	+2.9	78,791	89,083	+13.1
Asphalt, tar, and pitches	2,626	2,048	−22.0	8,634	8,414	−2.5
Liquefied petroleum gases and coal gases	7,709	7,201	−6.6	1,967	1,083	−44.9
Other petroleum and coal products [3]	16,051	16,523	+2.9	11,837	12,116	+2.4
Total	441,393	396,217	−10.2	557,775	557,879	--
Total mineral products	873,878	797,119	−8.8	797,972	797,598	--
Grand total, all commodities	1,484,919	1,390,960	−6.3	950,727	946,598	−.4
Mineral products, % of grand total:						
Metals and minerals except fuels	29.1	28.8	−1.0	25.3	25.3	--
Mineral energy resources and related products	29.7	28.5	−4.0	58.7	58.9	+.3
Total mineral products [4]	58.9	57.3	−2.7	83.9	84.3	+.5

[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 movements between points in the United States, Puerto Rico, and the Virgin Islands.
[3] Includes lubricants, naphtha, and other petroleum solvents, and miscellaneous petroleum and coal products.
[4] Data may not add to totals shown because of independent rounding.

Sources: Interstate Commerce Commission. Bureau of Accounts. Freight Commodity Statistics. Class I Railroad in the United States for the Years Ended December 31, 1970 and 1971. Department of the Army, Corps of Engineers. Waterborne Commerce of the United States, Part 5. National Summaries, calendar years 1970 and 1971, table 2.

Table 50.—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
1968	72.7	12.3	11.3	3.7	100.0
1969	71.0	12.7	11.8	4.5	100.0
1970	68.1	13.5	12.0	6.4	100.0
1971	69.2	10.7	10.9	9.2	100.0
1972	66.2	11.7	11.0	11.1	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.

Table 51.—Miles of utility gas main, by type of gas and type of main [1]

Type of gas and type of main	1967	1968	1969	1970	1971
All types:					
Field and gathering	63,710	64,440	64,914	66,556	66,500
Transmission	225,360	234,450	248,071	252,621	256,900
Distribution	539,200	562,750	578,639	595,653	611,300
Total	828,270	861,640	891,624	914,830	934,700
Natural gas:					
Field and gathering	63,710	64,440	64,914	66,556	NA
Transmission	224,790	233,940	247,559	252,609	
Distribution	529,340	554,030	569,999	587,760	
Total	817,840	852,410	882,472	906,925	NA
Manufactured gas:					
Transmission	--	--	--	--	NA
Distribution	1,140	1,070	914	545	
Total	1,140	1,070	914	545	NA
Mixed gas:					
Transmission	570	510	510	11	NA
Distribution	7,950	6,980	7,105	6,831	
Total	8,520	7,490	7,615	6,842	NA
Liquefied petroleum gas:					
Transmission	--	(2)	2	1	NA
Distribution	770	670	621	517	
Total	770	670	623	518	NA

NA Not available.
[1] Excludes service pipe. Data not adjusted to common diameter equivalent. Mileage shown as of end of each year.
[2] Less than 5 miles.

Source: American Gas Association. Gas Facts, a Statistical Record of the Gas Utility Industry in 1970, p. 53; 1971, p. 50. For earlier years, see Historical Statistics of the Gas Industry.

Table 52.—Petroleum pipelines, selected years

(Miles)

Year	Trunklines		Gathering lines	Total
	Crude	Products		
1959	70,317	44,483	75,182	189,982
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	75,066	72,406	71,132	218,604

Table 53.—Research and development activity

(Million dollars)

	Total			Funds expended: Company			Funds expended: Federal Government		
	1969 r	1970	1971	1969 r	1970	1971	1969 r	1970	1971
Petroleum refining and extraction	569	608	505	522	565	488	47	43	17
% of all industries	3.1	3.4	2.7	5.3	5.6	4.5	.6	.6	.2
Chemicals and allied products	1,731	1,812	1,822	1,538	1,624	1,639	192	188	183
% of all industries	9.5	10.1	9.9	15.6	16.1	15.2	2.3	2.4	2.4
All industries	18,318	17,858	18,420	9,867	10,073	10,749	8,451	7,785	7,671

Source: National Science Foundation. Research and Development in Industry. NSF 72-309, April 1972, table 2. Data from 1971 from Science Resources Studies Highlights. NSF 72-318, Dec. 13, 1972, p. 4.

Table 54.—Federal obligated funds for metallurgy and materials research

(Thousand dollars)

Federal agency	Fiscal year 1972 e			Fiscal year 1973 e		
	Basic research	Applied research	Total research	Basic research	Applied research	Total research
Department of Defense	30,281	71,405	101,686	36,627	73,482	110,109
Atomic Energy Commission	11,264	20,700	31,964	10,980	21,000	31,980
National Aeronautic and Space Administration	8,825	19,716	28,541	6,368	25,331	31,699
Bureau of Mines	498	15,265	15,763	317	16,886	17,203
National Science Foundation	9,672	4,800	14,472	14,691	10,080	24,771
Department of Agriculture	--	--	--	--	--	--
Department of Commerce	1,837	824	2,661	1,865	797	2,662
Federal Highway Administration	--	730	730	--	1,124	1,124
Other	21	5,804	5,825	21	7,706	7,727
Total	62,398	139,244	201,642	70,869	156,406	227,275

e Estimate.

Source: National Science Foundation. Federal Funds for Research, Development, and Other Scientific Activities. NSF 72-317, v. 21, August 1972, tables C-24, C-25, C-43, C-44, C-62, C-63.

Table 55.—Bureau of Mines obligations for mining and mineral research and development

(Thousand dollars)

Fiscal year	Applied research	Basic research	Development	Total
1969	25,934	4,051	5,033	35,018
1970	27,646	6,248	12,563	46,457
1971	32,214	6,525	21,561	60,300
1972	32,805	7,846	30,237	70,888
1973 e	34,087	7,031	37,279	78,397

e Estimate.

Table 56.—Bureau of mines obligations for total research, by field of science

(Thousand dollars)

	Fiscal year		
	1971	1972	1973 e
Engineering sciences	27,939	28,733	29,944
Physical sciences	7,455	10,525	9,796
Mathematical sciences	763	529	527
Environmental sciences	2,582	864	851
Total	38,739	40,651	41,118

e Estimate.

Table 57.—Summary of government inventories of strategic and critical materials, December 31, 1972

	Acquisition cost	Market value [1]
Total inventories in storage:		
National stockpile	$3,947,856,000	$4,893,774,300
Supplemental stockpile	1,359,907,600	1,438,417,100
Defense Production Act	649,171,400	362,112,800
Commodity Credit Corporation	--	--
Total on hand	5,956,935,000	6,694,304,200
On order:		
Inventories within objective:		
Total on hand	3,288,522,500	4,023,742,100
Inventories excess to objective:		
Total on hand	2,668,412,500	2,670,562,100

[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: Executive Office of the President, Office of Emergency Preparedness. Stockpile Report to the Congress, July-December 1972, p. 2.

Table 58.—U.S. Government disposal of mineral commodities, 1972

Commodity	Sales commitments	
	Quantity	Sales value
NATIONAL AND SUPPLEMENTAL STOCKPILE INVENTORIES		
Aluminum short tons	3,857	$2,226,553
Aluminum oxide do	6,878	671,770
Antimony do	70	72,954
Asbestos, amosite do	557	152,350
Asbestos, crocidolite do	10,357	2,129,400
Beryl do	2,452	735,750
Bismuth pounds	234,599	821,095
Cadmium do	934,400	1,746,200
Chromite, chemical short tons	1,596	[1] −197,813
Chromite, refractory short dry tons	13,620	363,670
Cobalt pounds	8,681,861	18,808,705
Columbium do	1,751,848	3,493,774
Diamond, industrial bort carats	1,295,000	2,538,354
Diamond, industrial stones do	1,740,000	10,359,227
Graphite, natural, Malagasy short tons	10,394	1,783,330
Lead do	49,825	13,438,305
Magnesium do	8,187	5,322,965
Manganese, battery grade, synthetic dioxide short dry tons	2,118	362,214
Manganese, metallurgical do	1,195,611	17,717,733
Mica, muscovite block pounds	1,142,042	861,921
Mica, muscovite film do	42,881	46,386
Mica, muscovite splittings do	7,107,355	741,944
Mica, phlogopite splittings do	334,783	139,663
Nickel do	77,712,878	119,619,293
Quartz crystals do	194,376	772,934
Rare earths short dry tons	29	16,785
Selenium pounds	16,090	133,993
Talc, steatite block and lump short tons	3	579
Talc, steatite block do	21	4,095
Talc, steatite ground do	500	3,000
Thorium nitrate pounds	170,710	139,982
Tin long tons	361	1,499,998
Vanadium short tons	1,567	6,570,197
Zinc do	211,488	68,978,259
Total	--	282,075,565
DEFENSE PRODUCTION ACT (DPA) INVENTORY		
Aluminum short tons	6,000	3,000,000
Cobalt pounds	487,007	1,105,294
Columbium do	402,893	585,109
Manganese, battery grade, synthetic dioxide short dry tons	1,528	519,767
Manganese, metallurgical do	48,125	672,633
Mica, muscovite block pounds	732,961	624,018
Tungsten do	3,457	2,200
Total	--	6,509,021
OTHER		
Bauxite long tons	110,000	500,000
Mercury flasks	512	117,660
Total	--	617,660
Grand total	--	289,202,246

[1] Negative sales figures represent adjustments of earlier disposal contracts.

Source: Executive Office of the President, Office of Emergency Preparedness. Stockpile Report to the Congress. January–June 1972, pp. 14–15; July–December 1972, pp. 14–15.

Table 59.—United Nations' indexes of world[1] mineral industry production

(1963=100)

Industry sector and geographic area	1970	1971	1972	1972 by quarters: 1st	2nd	3d	4th
EXTRACTIVE INDUSTRIES							
Metals:							
Non-Communist world	147	144	141	133	142	140	150
Industralized countries [2]	152	149	145	134	146	142	157
United States and Canada	136	132	128	122	134	122	133
Europe	121	124	126	121	134	115	133
European Economic Community [3]	90	86	82	83	83	76	84
European Free Trade Association [4]	138	144	148	145	163	123	161
Australia and New Zealand	192	206	214	193	202	234	227
Less industralized countries [5]	196	206	211	206	206	213	220
Latin America [6]	140	141	140	134	140	139	146
Asia [7]	139	143	143	141	141	141	147
Communist Europe [8]	187	201	211	215	211	211	206
World	156	157	157	151	158	155	163
Coal:							
Non-Communist world	90	88	83	78	87	79	87
Industrialized countries [2]	87	85	80	74	85	76	84
United States and Canada	124	118	124	123	131	118	123
Europe	74	73	63	55	67	59	70
European Economic Community [3]	73	71	61	52	66	57	68
European Free Trade Association [4]	64	61	61	66	59	61	61
Australia and New Zealand	151	159	181	162	189	189	186
Less industralized countries [5]	122	125	127	128	125	125	128
Latin America [6]	139	152	151	NA	NA	NA	NA
Asia [7]	121	121	123	123	123	120	125
Communist Europe [8]	124	128	130	133	127	127	133
World	104	105	103	101	104	100	106
Crude petroleum and natural gas:							
Non-Communist world	166	173	180	178	175	178	188
Industralized countries [2]	137	141	149	149	144	145	156
United States and Canada	129	130	135	133	132	135	138
Europe	234	276	322	348	293	272	375
European Economic Community [3]	262	318	377	412	342	311	443
European Free Trade Association [4]	NA	NA	NA	NA	NA	NA	NA
Australia and New Zealand	--	--	--	--	--	--	--
Less industralized countries [5]	196	206	211	206	206	213	220
Latin America [6]	121	118	112	108	112	114	114
Asia [7]	192	218	229	221	222	230	243
Communist Europe [8]	175	187	199	205	202	195	191
World	168	177	184	184	181	182	189
Total extractive industry:							
Non-Communist world	152	155	165	160	165	161	175
Industralized countries [2]	150	152	162	157	163	158	172
United States and Canada	140	141	152	146	153	152	158
Europe	148	152	160	158	161	147	172
European Economic Community [3]	144	147	154	153	155	142	166
European Free Trade Association [4]	122	125	126	126	133	112	135
Australia and New Zealand	165	176	187	168	185	200	195
Less industralized countries [5]	166	178	189	181	188	191	198
Latin America [6]	160	171	182	NA	NA	NA	NA
Asia [7]	182	204	214	205	209	217	226
Communist Europe [8]	155	165	174	177	175	172	170
World	146	151	155	152	155	154	158
PROCESSING INDUSTRIES							
Base metals:							
Non-Communist world	149	144	157	150	159	152	166
Industralized countries [2]	149	142	155	148	157	150	164
United States and Canada	128	120	134	128	139	127	141
Europe	147	141	149	145	152	144	157
European Economic Community [3]	142	135	140	136	143	136	146
European Free Trade Association [4]	152	150	160	161	162	143	172
Australia and New Zealand	150	139	140	131	131	144	155
Less industralized countries [5]	161	172	187	181	184	192	194
Latin America [6]	167	186	201	187	201	209	207
Asia [7]	157	152	171	175	161	169	178
Communist Europe [8]	164	174	184	187	183	184	183
World	154	153	164	161	166	162	171
Nonmetallic mineral products:							
Non-Communist world	140	147	157	140	160	161	164
Industralized countries [2]	137	141	150	135	155	155	157
United States and Canada	118	123	131	119	134	138	134
Europe	144	150	159	139	167	162	167
European Economic Community [3]	139	143	152	132	160	155	159
European Free Trade Association [4]	149	153	160	145	169	157	168
Australia and New Zealand	141	143	150	131	154	157	158
Less industralized countries [5]	170	191	206	187	205	213	220
Latin America [6]	173	193	210	194	207	217	221
Asia [7]	170	193	206	183	207	213	223

See footnotes at end of table.

Table 59.—United Nations' indexes of world [1] mineral industry production—Continued

(1963 = 100)

Industry sector and geographic area	1970	1971	1972	1972 by quarters			
				1st	2nd	3d	4th
PROCESSING INDUSTRIES—Continued							
Nonmetallic mineral products—Continued							
Communist Europe [8]	179	195	204	201	209	199	207
World	155	165	174	163	179	176	180
Chemicals, petroleum, and coal products:							
Non-Communist world	185	196	213	204	213	211	223
Industralized countries [2]	186	196	213	205	214	211	223
United States and Canada	171	180	199	188	201	203	206
Europe	194	203	218	214	218	207	231
European Economic Community [3]	190	200	211	209	212	201	224
European Free Trade Association [4]	190	197	210	207	213	197	223
Australia and New Zealand	169	192	203	187	206	198	219
Less industralized countries [5]	186	196	213	205	214	211	223
Latin America [6]	175	191	206	NA	NA	NA	NA
Asia [7]	187	201	224	220	225	218	232
Communist Europe [8]	213	234	258	255	261	256	259
World	191	203	222	215	223	220	230
OVERALL INDUSTRIAL PRODUCTION							
Non-Communist world	152	155	165	160	165	161	175
Industrialized countries [2]	150	152	162	157	163	158	172
United States and Canada	140	141	152	146	153	152	158
Europe	148	152	160	158	161	147	172
European Economic Community [3]	144	147	154	153	155	142	166
European Free Trade Association [4]	152	155	162	159	166	147	175
Australia and New Zealand	145	150	153	140	153	158	160
Less industralized countries [5]	150	152	162	157	163	158	172
Latin America [6]	160	171	182	NA	NA	NA	NA
Asia [7]	164	178	191	185	185	192	201
Communist Europe [8]	177	191	205	208	207	201	203
World	159	165	176	173	177	172	183

NA Not available.

[1] Excludes Albania, 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. These numbers are not comparable to those given in previous editions of this chapter for the European Economic Community, which did not include data for Denmark, Ireland, the United Kingdom, nations which joined the Community on January 1, 1973.

[4] Austria, Norway, Portugal, Sweden, and Switzerland. These numbers are not comparable to those given in previous editions of this chapter for the European Free Trade Association, which included data for Denmark and the United Kingdom.

[5] Countries not indicated in footnotes 1, 2, and 8.

[6] Corresponds to the United Nations classification "Caribbean, Central and South America".

[7] Corresponds to the United Nations classification "Asia, excluding Israel and Japan".

[8] Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Romania, and the U.S.S.R.

Source: United Nations. Monthly Bulletin of Statistics, August 1973, pp. xii-xxv.

Table 60.—Comparisons of world and U.S. production and U.S. imports of principal minerals and mineral fuels in 1972

Mineral	World production (thousand short tons unless otherwise stated) p	U.S. production (% of world production)	U.S. imports (% of world production)	Total U.S. production and imports (% of world production) 1972	Total U.S. production and imports (% of world production) 1971 r
METALLIC ORES AND CONCENTRATES					
Bauxite____thousand long tons__	64,844	2.8	17.6	20.4	22.9
Chromite	6,840	--	15.5	15.5	18.8
Copper (content of ore and concentrate)	7,314	22.8	2.2	25.0	25.3
Iron ore____thousand long tons__	756,488	10.0	4.7	14.7	15.8
Lead (content of ore and concentrate)	3,849	16.1	1.4	17.5	17.1
Mercury___thousand 76-pound flasks__	279,508	2.6	10.3	12.9	15.5
Molybdenum (content of ore and concentrate)____short tons__	87,625	64.0	(1)	64.0	64.6
Nickel (content of ore and concentrate)	698	2.4	24.6	27.0	22.7
Platinum group (Pt, Pd, etc.) thousand troy ounces__	4,613	(1)	21.9	22.3	18.9
Silver____do____	301,291	12.4	21.7	34.1	33.3
Titanium concentrates:					
Ilmenite [2]	3,586	20.3	5.1	25.4	24.2
Rutile [2]	357	--	54.6	54.6	50.7
Tungsten concentrate (60% tungsten dioxide)____short tons__	42,396	9.6	6.8	16.4	9.3
Zinc (content of ore and concentrate)	6,158	7.8	2.8	10.6	15.8
METALS, SMELTER BASIS					
Aluminum	12,103	34.1	6.6	40.7	40.6
Copper	7,300	23.2	2.4	25.6	24.3
Iron, pig	498,754	17.8	(1)	17.8	17.2
Lead	3,725	18.7	6.5	25.2	24.1
Magnesium	256	47.2	1.7	48.9	49.7
Steel ingots and castings	691,551	19.3	2.6	21.9	21.7
Tin____thousand long tons__	236	1.7	22.0	23.7	NA
Uranium oxide [2]____short tons__	27,277	50.1	8.4	58.5	57.9
Zinc	5,615	11.3	9.2	20.5	22.6
NONMETALS					
Asbestos	4,083	3.2	18.0	21.2	20.6
Cement	702,666	11.9	(1)	11.9	12.2
Diamond____thousand carats__	43,155	--	47.8	47.8	42.8
Feldspar	2,635	27.8	(1)	27.8	27.0
Fluorspar (marketable)	5,150	4.9	23.0	27.9	25.6
Gypsum	63,545	19.4	12.1	31.5	28.2
Mica (including scrap)	220	72.7	2.3	75.0	71.4
Nitrogen, agricultural [3 4]	38,693	23.7	2.4	26.1	27.5
Phosphate rock	103,866	39.3	(1)	39.3	40.6
Potash (K_2O equivalent)	22,465	11.8	13.2	25.0	24.5
Salt [4]	162,560	27.1	2.1	29.2	30.6
Sulfur, elemental_thousand long tons__	25,795	39.5	4.9	44.4	49.1
MINERAL ENERGY RESOURCES					
Crude petroleum____thousand barrels__	18,583,783	18.6	4.4	23.0	23.0
Natural gas____million cubic feet__	42,481,435	53.0	3.1	56.1	58.7
Bituminous coal and lignite	3,159,892	18.8	(1)	18.8	17.7
Anthracite	195,933	3.6	--	3.6	4.4

p Preliminary. r Revised. NA Not available.
1 Less than ½ unit.
2 World total exclusive of the U.S.S.R.
3 Year ended June 30, 1972.
4 Including Puerto Rico.

Table 61.—Value of world export trade in major mineral commodity groups

(Million U.S. dollars)

Commodity group [1]	1967 r	1968 r	1969	1970 r	1971
Metals:					
All ores, concentrates and scrap	5,030	5,590	6,340	8,010	7,370
Iron and steel	10,340	11,420	13,700	17,050	17,840
Nonferrous metals	8,010	9,440	r 10,870	12,200	10,400
Total metals	23,380	26,450	r 30,910	37,260	35,610
Nonmetals (crude only)	2,000	2,170	2,260	2,390	2,500
Mineral fuels	20,870	23,020	24,860	28,610	35,780
Grand total	46,250	51,640	r 58,030	68,260	73,890
All commodities	213,870	238,150	r 271,880	311,510	348,110

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 Section 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.

Table 62.—Mineral commodity export price indexes

(1963 = 100)

Year and quarter	Metal ores	Fuels	All crude minerals
1970	122	108	111
1971	126	127	127
1972:			
First quarter	136	141	140
Second quarter	135	143	141
Third quarter	136	143	141
Fourth quarter	130	144	140
Annual average	134	143	141

Source: Un. .d Nations, Monthly Bulletin of Statistics. New York, September 1973, p. xv.

Table 63.—Analysis of export price indexes

(1963 = 100)

Year and quarter	Developed areas		Developing areas	
	Total minerals	Nonferrous base metals	Total minerals	Nonferrous base metals
1970	122	167	104	191
1971	145	151	119	160
1972:				
First quarter	153	156	134	167
Second quarter	153	151	135	166
Third quarter	155	146	136	158
Fourth quarter	155	146	134	154
Annual average	154	150	135	161

Source: United Nations, Monthly Bulletin of Statistics, New York, September 1973, p. xv.

Technologic Trends in the Mineral Industries (Metals and Nonmetals Except Fuels)

By John L. Morning [1]

Environmental considerations, reduced ore grades, and the related increased quantities of material handled were the dominant concerns of the minerals industry in 1972.[2] As in recent years, the basic problem facing the domestic mineral industries was the widening gap between domestic demand and domestic production, a gap which has gradually developed since 1950.[3] Development of indigenous mineral resources faced the problem of increased costs to meet environmental regulations and health and safety standards. Environment factors continued to draw priorities as they became an integral part of mine and plant design. As of July 1972, 29 States had enacted surface mined area, environmental protection legislation. Generally, these laws required operators to prepare reclamation plans, obtain permits, and post performance bonds.

Despite these problems, the growth of the minerals industry (metals and nonmetals except fuels) in 1972 recovered from the downturn in 1971. Crude ore production rose 60 million tons, a 2% increase compared with that of 1971, to nearly 2.7 billion tons. Total value of metals and nonmetals output rose to $10.133 billion from $9.461 billion in 1971. In terms of 1972 constant dollars, value of mineral products has grown at an annual growth rate of 1.8% annually since 1963.

Nearly 4.2 billion tons of material was handled in 1972 compared with 2.9 billion tons in 1963 and 3.6 billion tons in 1968.

The downward trend in exploration and development activity continued for the third straight year primarily because of reduced activity at uranium operations. However, copper, gold, asbestos, and fluorspar operations reported significantly increased activity.

Materials Handled.—Total material handled at metal and nonmetal mines and quarries in the United States rose to nearly 4.2 billion tons in 1972, an increase of 2% compared with that of 1971. Table 1 shows data for the 13-year period of 1960 to 1972, which indicates that total material handled has grown at an annual rate of 3.2%. Most of the growth has occurred in the quantity of crude nonmetal ores produced and in the waste material handled at surface metal mines. Underground mining has been relatively stable, particularly for metal mines.

Crude ore output in 1972 totaled nearly 2.7 billion tons, 60 million tons higher than in 1971, but 10 million tons lower than in 1970 the record year. Although metal mines accounted for the minor portion of the total, the trend in the past 10 years has been to an increased share of the total crude ore output, which rose from 20% in 1963 to 22% in 1972. Copper and iron ore accounted for 83% of metal mine crude ore output, whereas phosphate rock, sand and gravel, and stone accounted for 93% of the nonmetal crude ore production. For comparison, the percentages for the same commodities in 1963 were 74% and 93%, respectively, and in 1968, 81% and 91%, respectively.

Waste material accounted for over one-third of total material handled in the minerals industry, rising to over 1.5 billion tons during the year. A large portion of the total came from stripping activities in copper, iron ore, uranium, and phosphate rock. For metal mines, copper led in both

[1] Supervisory physical scientist, Division of Ferrous Metals—Mineral Supply.
[2] Staff, Bureau of Mines. Technologic and Related Trends In the Mineral Industries, BuMines I.C. 8603, 1972, 44 pp.
[3] Secretary of the Interior. First Annual Report of the Secretary of the Interior Under the Mining and Minerals Policy Act of 1970 (P.L. 91–631). March 1972, 142 pp.

crude ore production and waste material handled, and for nonmetal operations, stone led in crude ore production and phosphate rock in waste material handled.

Eleven States (Arizona, California, Florida, Michigan, Minnesota, Montana, Nevada, New Mexico, Texas, Utah, and Wyoming) compared with 10 in 1971 handled more than 100 million tons of material. Illinois was dropped from the list, while Montana and Nevada were added. Three States reported handling between 90 and 100 million tons of material. Arizona and Florida led the nation in both total material handled and crude ore output; both States produced over 200 million tons of crude ore. Arizona and Florida have led the nation in total materials handled since 1965.

Magnitude of the Mining Industry.—Crude ore production was reported from 13,723 mines and quarries. The data are comparable with 1971 but are not comparable with other years owing to elimination from the data of brine and pumping operations. Of the total mines reporting production, clay mines totaled 1,064; sand and gravel operations, 6,690; crushed and broken stone operations, 4,448; dimension stone operations, 391; other nonmetal mines, 531; and metal mines, 599. In addition, there were 103 wells, ponds, or pumping operations.

Excluding clay, sand and gravel, and stone operations, a total of 1,130 metal and nonmetal mines reported production of crude ore or waste compared with 1,299 mines in 1971. Most of the decrease was accounted for by small mines producing less than 10,000 tons of crude ore annually. In metal mining, lead and zinc and uranium mines decreased in number primarily because of the soft market for lead and zinc and the lack of markets for uranium. Both placer gold and silver mines showed an increase in number owing to increased prices of these precious metals. The number of mines also decreased for most nonmetals. Small feldspar mines decreased owing to competition from larger more economical mines. Phosphate rock mines decreased by 10 owing to changes in statistical counting.

Crude ore production ranged from less than 1 ton of ore to nearly 37 million tons while total material handled ranged to nearly 125 million tons.

The 25 leading metal mines produced nearly 384 million tons of crude ore, 8% higher than the figure for 1971, and accounted for 67% of the total output of crude ore from metal mines. The same mines also handled 1,147 million tons of material, an increase of 9% over that of 1971, and represented 69% of the total material handled at metal mines.

The 25 leading nonmetal mines produced 169 million tons of crude ore and handled 409 million tons of material. This production represented 8% and 16% respectively, of total crude ore and total material handled at nonmetal mines.

Value of Principal Mineral Products.—When possible, the measurement of value used in table 4 is mine output, the form in which the minerals are extracted from the ground. For some commodities, the value is of beneficiated products. Values for some metals are assigned according to the average selling price of refined metal.

Value patterns for most mineral commodities rose in 1972 after suffering a decline in 1971, but a few commodities remained unchanged and a few declined in value. Unit values for ore at underground mines were generally higher than those from surface mining.

The contribution of byproducts to the value of ore continued to be more significant to the output of metal ores than to that of nonmetal ores. Byproducts accounted for 8% of value of metal ores and 1% of nonmetal ores. Excluding the large volume commodities of stone and sand and gravel, byproducts contributed 7% to the value of combined metal and nonmetal ores and 3% to nonmetal ores. Byproducts enhanced the value of ores of lead 28%, silver 20%, zinc 20%, fluorspar 13%, feldspar 11%, and mica (scrap) 8%.

Comparison of Production From Surface and Underground Mines.—Surface mining continued to account for 94% of all crude ore production and 96% of total material handled. Although there is little variation in the year-to-year ratio of production from surface and underground mines, the long-term trend indicates an increasing percentage of material mined by surface methods. In 1963, surface mining accounted for 93% of crude ore production and 95% of total material handled. The biggest change between the comparison years was in metal mining as the percentage of surface crude ore production increased from 82% in 1963 to 85% in 1972, and total material handled rose from 91% to 95%. Most metal commodities during the 10-year span especially copper, lode gold, and iron ore indicated higher percentages mined by surface methods, however silver and zinc showed a reversal of the trend.

Nonmetal mining statistics are dominated by the large volume commodities—clay, phosphate rock, sand and gravel, and stone —which are primarily mined by surface methods. Therefore, over the years of this survey no discernable trend has been evident in the totals for nonmetal commodities. Over the 10-year period, production of fluorspar, gypsum, and vermiculite crude ore mined by surface methods has increased.

Two metal commodities, antimony and lead, and three nonmetal commodities, potassium salts, sodium carbonate, and wollastonite were mined entirely by underground methods.

Ratio of Ore Treated to Marketable Product.—The ratio of ore treated to marketable product—that is, the amount of ore that must be processed to produce a given amount of marketable material—varies with the mineral commodity; a low ratio is, of course, desirable. The ratio ultimately depends on the grade of ore treated and the type of valuable mineral content; for example, in the last decade the ratios for copper and iron have risen, indicating that lower grade ores are being processed. For copper, the average grade of ore has declined so that more ore must be processed per unit of product; for iron, new technology has enabled iron ore pellets of higher iron content to be produced, thus effectively upgrading the ore and increasing the ratio.

Over the last 10 years, the ratio for lead has declined because higher grade deposits were phased into operation in the late 1960's. Bauxite and titanium have had a relatively constant ratio, as have most nonmetal commodities; for many nonmetals the ratio is essentially 1 to 1. The barite ratio has declined in recent years because new mines in Alaska and Nevada have come into production, and the use of this higher grade ore has lowered the ratio.

Exploration and Development.—The downward trend in exploration and development continued in 1972 when 25 million feet, 91% of that in 1971, was reported. Exploration and development statistical data since 1965 have been dominated by activity at uranium mines. Total reported footage for uranium rose from nearly 3 million feet in 1965 to nearly 24 million feet in 1969. During the past 3 years, reported footage has steadily declined, reaching 13 million feet in 1972.

Total footage for metals dropped 2.3 million feet, while nonmetallic footage dropped 303,000 feet. Changes in exploration and development footage for both metals and nonmetals commodities were mixed, with significant increases reported for copper, gold, asbestos, and fluorspar, and significant decreases for silver, lead, uranium, gypsum, and phosphate rock.

Three methods of drilling, diamond, rotary, and percussion, accounted for 94% of the reported footage. Metal mines accounted for 98% of the total footage. However, clay, sand and gravel, and stone operations were not canvassed.

Six States reported over 1 million feet of exploration work. South Dakota led with 20% of the total, followed by New Mexico, 19%; Wyoming, 19%; and Utah, 10%. Exploration and development activity in South Dakota was primarily for gold and uranium, in New Mexico for uranium and copper, in Wyoming for uranium, and in Utah for copper and uranium. Rotary drilling accounted for 53% of all activity. Only percussion drilling indicated an increase in activity as all other methods decreased compared with that of 1971.

Total material handled (ore and waste) from exploration and development activity rose to a record high in 1972. Increased material handled from stripping work at copper, iron ore, and uranium mines more than offset a decrease in tonnage handled at nonmetal mines. Underground tonnage from work such as shaft sinking, raising, and drifting and crosscutting was down sharply at metal mines. Increased activity at underground fluorspar mines accounted for increased material handled from drifting and crosscutting at nonmetal mines.

Three States produced over 100 million tons of material from exploration and development work; two more than in 1971. Arizona led as a result of stripping work in copper, followed by Florida and Wyoming.

Explosives.—The total consumption of explosives in all industries continued to grow and set new yearly record highs. The mining industry accounted for 80% of industrial explosives consumed in 1972, compared with 76.3% in 1968. Total industrial explosives consumption increased by 4.5% compared with that of 1971.

The use of pellet and granular black blasting powder for industrial purposes ceased during 1971. Black blasting powder consumption in the minerals industry reached a record high of 245 million pounds in 1917, mainly in the coal industry. As new explosives were developed, the use of black blasting powder in the minerals industry gradually declined, reaching less than 1 million pounds per year in 1955.

Permissible explosives, primarily used in coal mining, also has shown decreased usage in the minerals industry since reaching a record high consumption of 126 million pounds in 1948. The use of other mining methods such as strip mining, auger mining, and continuous mining machines in coal accounted for the decline in usage. From 1965 through 1967, interest in using permissible explosives in quarrying and nonmetal mining surged as consumption trebled; however, interest waned and consumption in 1971 and 1972 returned to the levels of that of 1964.

Of the 2.1 billion pounds of explosives consumed in the minerals industry, coal mining accounted for 57%, metal mining 20%, and quarrying and nonmetal mining 23%.

The five top ranked States in order of total explosives and blasting agents consumed were as follows: Kentucky, Pennsylvania, West Virginia, Indiana, and Arizona. In 1972 eight States consumed over 100 million pounds of explosives. Leading States in the use of explosives and blasting agents for coal mining were Kentucky and Indiana; for metal mining, Arizona and Minnesota; and for quarrying and nonmetal mining; Pennsylvania and Illinois.

Beginning in 1972, the Institute of Makers of Explosives (IME) adopted new product classifications for industrial explosives and blasting agents. All of the changes occurred in blasting agents and black blasting powder was deleted as a category. As a result of the change in classification, detailed statistics are not directly comparable with previous years.

More detailed explosive information is published in the Annual Explosive issue of Mineral Industry Surveys prepared by the Division of Nonmetallic Minerals, Mineral Supply, 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
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
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

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

Table 2.—Material handled at surface and underground mines, by commodity, in 1972 [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] 2,560	[3] 9,230	[3] 11,800	W	W	W	[3] 2,560	9,230	11,800
Copper	237,000	683,000	920,000	34,700	685	35,400	271,000	684,000	955,000
Gold:									
Lode	3,540	16,000	19,500	1,700	219	1,910	5,230	16,200	21,500
Placer	1,330	106	1,430	--	(4)	(4)	1,330	106	1,430
Iron ore	197,000	167,000	364,000	11,600	1,310	12,900	209,000	168,000	377,000
Lead	(4)	102	102	9,560	452	10,000	9,560	554	10,100
Mercury	51	53	105	30	3	34	82	57	138
Silver	69	32	100	588	160	749	657	192	849
Titanium: Ilmenite	26,100	823	27,000	--	--	--	26,100	823	27,000
Tungsten	8	52	60	734	130	864	741	182	923
Uranium	3,800	171,000	175,000	2,690	654	3,350	6,450	172,000	178,000
Zinc	19	--	19	8,180	948	9,130	8,210	948	9,150
Other [5]	19,400	32,300	51,600	15,800	562	16,300	35,200	32,900	68,000
Total metals [2]	491,000	1,080,000	1,570,000	85,700	5,120	90,800	576,000	1,080,000	1,660,000
NONMETALS									
Abrasives [6]	54	17	71	53	--	53	107	17	124
Asbestos	[3] 2,300	[3] 759	[3] 3,060	W	W	W	2,300	759	3,060
Barite	4,190	2,070	6,260	116	14	130	4,310	2,080	6,390
Clays	55,200	[e] 48,000	103,000	886	[e] 13	899	56,100	48,000	104,000
Diatomite	603	2,490	3,100	--	--	--	603	2,490	3,100
Feldspar	1,560	210	1,770	--	--	--	1,560	210	1,770
Fluorspar	119	6	125	529	--	529	649	6	655
Gypsum	9,820	15,700	25,500	2,720	4	2,720	12,500	15,700	28,200
Mica (scrap)	579	357	936	--	1	1	579	358	937
Perlite	649	35	684	W	W	W	649	35	684
Phosphate rock	128,000	254,000	382,000	240	1	241	128,000	254,000	382,000
Potassium salts	--	--	--	17,300	1,350	18,600	17,300	1,350	18,600
Pumice	3,820	49	3,870	--	--	--	3,820	49	3,870
Salt	423	2	425	13,700	46	13,800	14,100	48	14,200
Sand and gravel	913,000	--	913,000	--	--	--	913,000	--	913,000
Sodium carbonate (natural)	--	--	--	5,120	3,090	8,210	5,120	3,090	8,210

Stone:									
Crushed and broken	883,000	e 72,400	955,000	35,400	e 283	35,700	918,000	72,700	991,000
Dimension	e 2,750	e 1,450	4,200	2	--	2	2,750	1,450	4,200
Talc, soapstone, and pyrophyllite	1,490	1,320	2,810	704	28	732	2,190	1,350	3,540
Other [7]	10,600	16,800	27,400	102	--	102	10,700	17,000	27,400
Total nonmetals [2]	2,020,000	415,000	2,430,000	76,900	4,820	81,800	2,100,000	420,000	2,520,000
Grand total [2]	2,500,000	1,500,000	4,000,000	163,000	9,950	173,000	2,670,000	1,510,000	4,180,000

[e] Estimate. W Withheld to avoid disclosing individual company confidential data, included with "Surface."
[1] Excludes material from wells, ponds, or pumping stations.
[2] Data may not add to totals shown because of independent rounding.
[3] Includes underground; the Bureau of Mines is not at liberty to publish separately.
[4] Less than ½ unit.
[5] Antimony, beryllium, magnesium, manganese, molybdenum, nickel, platinum-group metals, rare-earth metals, tin, and vanadium.
[6] Emery, garnet, and tripoli.
[7] Abrasive stone, aplite, boron minerals, graphite, greensand marl, iron oxide pigments (crude), kyanite, lithium minerals, magnesite, millstones, olivine, vermiculite, and wollastonite.

Table 3.—Material handled at surface and underground mines (including sand and gravel and stone), by State, in 1972 [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	29,100	3,540	32,600	W	--	W	29,100	3,540	32,600
Alaska	18,100	225	18,300	56	30	86	18,200	255	18,400
Arizona	177,000	371,000	548,000	23,200	527	23,200	201,000	371,000	572,000
Arkansas	31,400	11,600	43,000	793	14	807	32,200	11,600	43,800
California	171,000	37,000	208,000	1,230	147	1,370	172,000	37,100	209,000
Colorado	34,200	152	34,400	17,600	1,010	18,600	51,800	1,160	53,000
Connecticut	15,800	45	15,800	--	--	--	15,800	45	15,800
Delaware	2,270	--	2,270	--	--	--	2,270	--	2,270
Florida	209,000	214,000	423,000	474	--	474	210,000	214,000	424,000
Georgia	51,000	51	51,000	933	--	933	52,000	51	52,000
Hawaii	6,020	--	6,020	--	--	--	6,020	--	6,020
Idaho	14,900	17,400	32,400	1,400	199	1,600	16,300	17,600	33,900
Illinois	94,800	--	94,800	3,460	--	3,460	98,300	--	98,300
Indiana	56,600	--	56,600	1,200	4	1,200	57,800	4	57,800
Iowa	45,000	3,780	48,800	1,700	--	1,700	46,700	3,780	50,500
Kansas	24,900	38	24,900	3,080	4	3,090	28,000	43	28,000
Kentucky	37,800	--	37,800	6,040	--	6,040	43,900	--	43,900
Louisiana	29,400	--	29,400	6,190	12	6,200	35,600	12	35,600
Maine	13,000	--	13,000	W	--	W	13,000	--	13,000
Maryland	33,100	--	33,100	W	--	W	33,100	--	33,100
Massachusetts	27,100	--	27,100	--	--	--	27,100	--	27,100
Michigan	130,000	24,000	154,000	12,100	109	12,200	143,000	24,000	167,000
Minnesota	184,000	103,000	286,000	--	--	--	184,000	103,000	286,000
Mississippi	16,000	--	16,000	--	--	--	16,000	--	16,000
Missouri	50,000	1,780	52,100	22,100	889	23,000	72,400	2,670	75,100
Montana	35,500	93,700	129,000	907	93	1,000	36,500	94,000	130,000
Nebraska	17,300	--	17,300	789	--	789	18,100	--	18,100
Nevada	37,500	72,900	110,000	191	15	206	37,700	72,900	111,000
New Hampshire	6,600	--	6,600	--	--	--	6,600	--	6,600
New Jersey	39,200	--	39,200	211	--	211	39,400	--	39,400
New Mexico	38,300	111,000	150,000	20,100	1,620	21,700	58,400	113,000	171,000
New York	71,000	1,860	72,800	4,700	20	4,720	75,700	1,880	77,600
North Carolina	55,300	10,700	66,100	15	--	15	55,400	10,700	65,300
North Dakota	6,780	--	6,780	--	--	--	6,780	--	6,780
Ohio	93,400	--	93,400	6,220	--	6,220	99,600	--	99,600
Oklahoma	27,800	9,930	37,700	W	--	W	27,800	9,930	37,700
Oregon	38,500	721	39,300	2	1	3	38,500	722	39,300
Pennsylvania	87,700	1,250	89,000	4,400	739	5,140	92,100	2,000	94,100
Rhode Island	2,450	--	2,450	--	--	--	2,450	--	2,450
South Carolina	23,000	--	23,000	--	--	--	23,000	--	23,000
South Dakota	15,900	649	16,600	W	W	W	15,900	649	16,600
Tennessee	49,100	3,880	53,000	8,040	135	8,180	57,100	4,020	61,000
Texas	103,000	16,700	120,000	283	1	284	104,000	16,700	120,000
Utah	60,800	102,000	162,000	736	248	984	61,500	102,000	163,000
Vermont	7,460	590	8,050	342	4	346	7,800	594	8,400
Virginia	54,800	179	55,000	1,680	546	2,230	56,500	725	57,200
Washington	38,000	1,130	39,200	284	2	286	38,300	1,130	39,500

West Virginia	14,900	--	14,900	2,730	--	2,730	17,600	--	17,600
Wisconsin	58,400	5,400	63,800	429	--	429	58,900	5,400	64,300
Wyoming	21,800	154,000	176,000	6,040	3,090	9,130	27,800	157,000	185,000
Undistributed [3]	1,500	122,000	123,000	3,040	479	3,520	4,540	122,000	127,000
Total [2]	2,500,000	1,500,000	4,000,000	163,000	9,950	173,000	2,670,000	1,510,000	4,180,000

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 1.

Table 4.—Value of principal mineral products and byproducts of surface and underground ores mined in the United States, in 1972

(Value per ton)

Ore	Surface			Underground			All mines		
	Principal mineral product	Byproduct	Total	Principal mineral product	Byproduct	Total	Principal mineral product	Byproduct	Total
METALS									
Bauxite	[1] $90.07	$0.34	$9.41	W	--	W	$9.07	$0.34	$9.41
Copper	5.91	.41	6.32	$8.79	$0.76	$9.55	6.28	.46	6.74
Gold:									
Lode	6.64	.05	6.69	17.31	2.40	19.71	10.18	.83	11.01
Placer	.56	.01	.57	--	--	--	.56	.01	.57
Iron ore	4.33	.01	4.34	7.77	--	7.77	4.52	.01	4.53
Lead	49.57	59.41	108.98	17.71	6.99	24.70	17.71	6.99	24.70
Mercury	18.67	--	18.67	18.50	--	18.50	18.60	--	18.60
Silver	2.32	3.45	5.77	32.23	7.82	40.05	29.09	7.36	36.45
Titanium: Ilmenite	.62	.23	.85	--	--	--	.62	.23	.85
Tungsten	7.15	--	7.15	19.29	1.82	21.11	19.18	1.80	20.98
Uranium	24.37	.07	24.44	26.15	5.15	31.30	25.09	2.13	27.22
Zinc	8.24	12.11	20.35	15.09	3.55	18.64	15.02	3.64	18.66
Average value [2]	5.07	.27	5.34	10.68	1.75	12.43	5.91	.49	6.40
NONMETALS									
Asbestos	[1] 5.84	.01	[1] 5.85	W	--	W	5.84	.01	5.85
Barite	2.65	.04	2.69	33.43	--	33.43	3.48	.04	3.52
Clays	5.20	--	5.20	8.56	--	8.56	5.25	--	5.25
Diatomite	65.19	--	65.19	--	--	--	65.19	--	65.19
Feldspar	5.85	.76	6.61	--	--	--	5.85	.76	6.61
Fluorspar	9.68	--	9.68	30.29	4.67	34.96	26.51	3.82	30.33
Gypsum	3.59	.04	3.63	4.87	--	4.87	3.87	.03	3.90
Mica (scrap)	23.95	1.96	25.91	--	--	--	23.95	1.96	25.91
Perlite	[1] 11.44	--	[1] 11.44	W	--	W	11.44	--	11.44
Phosphate rock	1.61	.06	1.67	9.12	--	9.12	1.62	.06	1.68
Potassium salts	--	--	--	5.27	.07	5.34	5.27	.07	5.34
Pumice	1.71	--	1.71	--	--	--	1.71	--	1.71
Salt	2.14	1.09	3.23	6.21	.87	7.08	6.09	.88	6.97
Sand and gravel	1.31	--	1.31	--	--	--	1.31	--	1.31
Sodium carbonate (natural)	--	--	--	12.27	--	12.27	12.27	--	12.27
Stone:									
Crushed and broken	1.72	.01	1.73	2.12	--	2.12	1.74	.01	1.75
Dimension	60.32	--	60.32	44.68	--	44.68	60.30	--	60.30
Talc, soapstone, pyrophyllite	3.03	--	3.03	4.72	--	4.72	3.57	--	3.57
Vermiculite	1.90	--	1.90	--	--	--	1.90	--	1.90
Average value [2]	1.74	.01	1.75	4.73	.21	4.94	1.86	.02	1.88
Average value-metals and nonmetals [2]	2.39	.06	2.45	7.85	1.02	8.87	2.72	.12	2.84
Average value-nonmetals (excluding stone, and sand and gravel) [2]	3.31	.06	3.37	6.93	.38	7.31	3.89	.11	4.00
Average value-metals and nonmetals (excluding stone, and sand and gravel) [2]	4.53	.20	4.73	9.44	1.30	10.74	5.28	.37	5.65

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.
[2] Includes unpublished data.

Table 5.—Crude ore and total material handled at surface and underground mines, by commodity, in 1972

(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	87.3	12.7	96.3	3.7
Gold:				
Lode	53.3	46.7	91.1	8.9
Placer	100.0	--	100.0	--
Iron ore	94.4	5.6	96.6	3.4
Lead	--	100.0	1.0	99.0
Mercury	60.5	39.5	75.7	24.3
Molybdenum	30.2	69.8	68.9	31.1
Nickel	100.0	--	100.0	--
Platinum-group metals	100.0	--	100.0	--
Rare-earth metals	100.0	--	100.0	--
Silver	2.8	97.2	11.8	88.2
Tin	100.0	--	100.0	--
Titanium: Ilmenite	100.0	--	100 0	--
Tungsten	1.0	99.0	6.5	93.5
Uranium	58.6	41.4	98.1	1.9
Vanadium	100.0	--	100.0	--
Zinc	0.2	99.8	0.2	99.8
Total metals	85.1	14.9	94.5	5.5
NONMETALS				
Abrasives:				
Emery	100.0	--	100.0	--
Garnet	100.0	--	100.0	--
Tripoli	38.2	61.8	48.3	51.7
Aplite	100.0	--	100.0	--
Asbestos	99.2	0.8	99.4	0.6
Barite	97.3	2.7	98.0	2.0
Boron minerals	100.0	--	100.0	--
Calcium-magnesium chloride	100.0	--	100.0	--
Clays	98.4	1.6	98.4	1.6
Diatomite	100.0	--	100.0	--
Feldspar	100.0	--	100.0	--
Fluorspar	18.4	81.6	19.2	80.8
Graphite	100.0	--	100.0	--
Greensand marl	100.0	--	100.0	--
Gypsum	78.3	21.7	90.3	9.7
Iron oxide pigments (crude)	100.0	--	100.0	--
Kyanite	100.0	--	100.0	--
Lithium minerals	100.0	--	100.0	--
Magnesite	100.0	--	100.0	--
Mica (scrap)	100.0	--	99.9	0.1
Mica (sheet)	100.0	--	100.0	--
Millstone	100.0	--	100.0	--
Olivine	100.0	--	100.0	--
Perlite	99.3	0.7	99.3	0.7
Phosphate rock	99.8	0.2	99.9	0.1
Potassium salts	--	100.0	--	100.0
Pumice	100.0	--	100.0	--
Salt	3.0	97.0	3.0	97.0
Sand and gravel	100.0	--	100.0	--
Sodium carbonate (natural)	--	100.0	--	100.0
Stone:				
Crushed and broken	96.1	3.9	96.1	3.9
Dimension	99.9	0.1	99.9	0.1
Talc, soapstone, pyrophyllite	67.6	32.4	79.3	20.7
Vermiculite	100.0	--	100.0	--
Wollastonite	--	100.0	--	100.0
Total nonmetals	96.3	3.7	96.6	3.4
Grand total	93.9	6.1	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, by State, in 1972

(Percent)

State	Crude ore		Total material	
	Surface	Underground	Surface	Underground
Alabama	98	2	98	2
Alaska	100	--	100	--
Arizona	88	12	96	4
Arkansas	98	2	98	2
California	99	1	99	1
Colorado	66	34	65	35
Connecticut	100	--	100	--
Delaware	100	--	100	--
Florida	100	--	100	--
Georgia	98	2	98	2
Hawaii	100	--	100	--
Idaho	91	9	95	5
Illinois	97	3	97	3
Indiana	98	2	98	2
Iowa	96	4	96	4
Kansas	89	11	89	11
Kentucky	86	14	86	14
Louisiana	83	17	83	17
Maine	99	1	99	1
Maryland	100	--	100	--
Massachusetts	100	--	100	--
Michigan	92	8	93	7
Minnesota	100	--	100	--
Mississippi	100	--	100	--
Missouri	70	30	69	31
Montana	98	2	99	1
Nebraska	96	4	96	4
Nevada	100	--	100	--
New Hampshire	100	--	100	--
New Jersey	99	1	99	1
New Mexico	66	34	87	13
New York	94	6	94	6
North Carolina	100	--	100	--
North Dakota	100	--	100	--
Ohio	94	6	94	6
Oklahoma	97	3	98	2
Oregon	100	--	100	--
Pennsylvania	95	5	95	5
Rhode Island	100	--	100	--
South Carolina	100	--	100	--
South Dakota	92	8	91	9
Tennessee	86	14	87	13
Texas	100	--	100	--
Utah	99	1	99	1
Vermont	96	4	96	4
Virginia	97	3	96	4
Washington	99	1	99	1
West Virginia	85	15	85	15
Wisconsin	99	1	99	1
Wyoming	78	22	95	5
Total	94	6	96	4

Table 7.—Number of domestic metal and nonmetal mines in 1972, 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	16	--	3	9	4	--	--
Copper	73	15	3	9	15	23	8
Gold:							
Lode	29	21	1	3	2	2	--
Placer	42	24	10	7	1	--	--
Iron ore	58	--	9	4	15	26	4
Lead	29	6	6	3	9	5	--
Mercury	19	8	8	3	--	--	--
Silver	49	31	10	6	2	--	--
Titanium: Ilmenite	6	--	--	--	--	6	--
Tungsten	39	33	4	1	1	--	--
Uranium	189	32	79	61	17	--	--
Zinc	32	1	1	9	21	--	--
Other [2]	18	5	1	4	2	5	1
Total metals	599	176	135	119	89	67	13
NONMETALS							
Abrasives [3]	12	3	5	4	--	--	--
Asbestos	8	2	--	2	3	1	--
Barite	30	--	3	11	16	--	--
Boron minerals	2	--	--	1	--	1	--
Clays	1,064	71	246	579	168	--	--
Diatomite	11	2	2	6	1	--	--
Feldspar	22	--	5	12	5	--	--
Fluorspar	14	1	6	4	3	--	--
Gypsum	65	--	6	15	44	--	--
Mica (scrap)	18	4	5	7	2	--	--
Mica (sheet)	1	1	--	--	--	--	--
Perlite	13	1	5	5	2	--	--
Phosphate rock	45	1	5	7	12	18	2
Potassium salts	7	--	--	--	--	7	--
Pumice	180	46	53	71	10	--	--
Salt	18	--	2	1	8	7	--
Sand and gravel	6,690	165	960	3,365	2,098	102	--
Sodium carbonate (natural)	3	--	--	--	--	3	--
Stone:							
Crushed and broken	4,448	258	749	1,718	1,550	172	1
Dimension	391	204	155	32	--	--	--
Talc, soapstone, pyrophyllite	55	3	22	24	6	--	--
Vermiculite	3	--	1	--	1	1	--
Other [4]	24	10	3	4	7	--	--
Total nonmetals	13,124	772	2,233	5,868	3,936	312	3
Grand total	13,723	948	2,368	5,987	4,025	379	16

[1] Excludes wells, ponds, or pumping operations.
[2] Antimony, beryllium, magnesium, manganiferrous ore, molybdenum, nickel, platinum-group metals, rare earth, tin, and vanadium.
[3] Emery, garnet and tripoli.
[4] Aplite, calcium chloride, graphite, greensand marl, iron oxide pigments (crude), kyanite, lithium minerals, magnesite, millstones, olivine, and wollastonite.

Table 8.—Twenty-five leading metal and nonmetal[1] mines in the United States in 1972, in order of output of crude ore

Mine	State	Operator	Commodity	Mining method
		METALS		
Utah Copper	Utah	Kennecott Copper Corp	Copper	Open pit.
Erie Commercial (Hoyt Lake)	Minn	Pickands Mather & Co	Iron ore	Do.
Minntac	do	United States Steel Corp	do	Do.
Peter Mitchell	do	Reserve Mining Co	do	Do.
Sierrita	Ariz	Duval Sierrita Corp	Copper	Do.
San Manuel	do	Magma Copper Co	do	Caving.
Twin Buttes	do	The Anaconda Company	do	Open pit.
Morenci	do	Phelps Dodge Corp	do	Do.
Berkeley Pit	Mont	The Anaconda Company	do	Do.
Pima	Ariz	Pima Mining Co	do	Do.
Climax	Colo	American Metal Climax, Inc	Molybdenum	Caving.
Empire	Mich	Cleveland-Cliffs Iron Co	Iron ore	Open pit.
Tyrone	N. Mex	Phelps Dodge Corp	Copper	Do.
Yerington	Nev	The Anaconda Company	do	Do.
New Cornelia	Ariz	Phelps Dodge Corp	do	Do.
Ray Pit	do	Kennecott Copper Corp	do	Do.
Republic	Mich	Cleveland-Cliffs Iron Co	Iron ore	Do.
Mission	Ariz	American Smelting & Refining Co.	Copper	Do.
Butler Project	Minn	The Hanna Mining Co	Iron ore	Do.
White Pine	Mich	White Pine Copper Co	Copper	Open stopes.
Trail Ridge	Fla	E.I. duPont de Nemours & Co.	Ilmenite	Dredging.
Inspiration	Ariz	Inspiration Consolidated Copper Co.	Copper	Open pit.
Highland	Fla	E.I. duPont de Nemours & Co.	Ilmenite	Dredging.
Thunderbird	Minn	Oglebay Norton Co	Iron ore	Open pit.
Mineral Park	Ariz	Duval Corp	Copper	Do.
		NONMETALS		
Suwannee	Fla	Occidental Petroleum Corp	Phosphate rock	Open pit.
Calcite	Mich	United States Steel Corp	Stone	Open quarry.
Ft. Meade	Fla	Mobil Oil Corp	Phosphate rock	Open pit.
Noralyn	do	International Minerals & Chemical Corp.	do	Do.
Kingsford	do	do	do	Do.
Haynsworth	do	American Cyanamid Co	do	Do.
Rockland	do	United States Steel Corp	do	Do.
Payne Creek	do	Continental Oil Co	do	Do.
Thornton	Ill	General Dynamics Corp	Stone	Open quarry.
Stoneport	Mich	Presque Isle Corp	do	Do.
Pennsuco	Fla	Maule Industries, Inc	do	Do.
Bonny Lake	do	W. R. Grace & Co	Phosphate rock	Open pit.
Palmetto	do	Continental Oil Co	do	Do.
Silver City	do	Swift Agricultural Chemicals Corp.	do	Do.
Clear Spring	do	International Minerals & Chemical Corp.	do	Do.
Clinton	N.Y	Lone Star Industries, Inc	Stone	Open quarry.
Tampa Agricultural Chemicals Operation.	Fla	Gardinier, Inc	Phosphate rock	Open pit.
Feld	Tex	Texas Crushed Stone Co	Stone	Open quarry.
McCook 378	Ill	Vulcan Materials Co	do	Do.
Tenoroc	Fla	Borden, Inc	Phosphate rock	Open pit.
Nichols	do	Mobil Oil Corp	do	Do.
International	N. Mex	International Minerals & Chemical Corp.	Potassium salts	Open stopes.
Zonolite	Mont	W. R. Grace & Co	Vermiculite	Open pit.
Peerless	Mo	Mississippi Lime Co	Stone	Open stopes.
Saddle Creek	Fla	Continental Oil Co	Phosphate rock	Open pit.

[1] Brines and materials from wells excepted.

Table 9.—Twenty-five leading metal and nonmetal[1] mines in the United States in 1972, in order of output of total materials handled

Mine	State	Operator	Commodity	Mining method
		METALS		
Utah Copper	Utah	Kennecott Copper Corp	Copper	Open pit.
Twin Buttes	Ariz	The Anaconda Company	do	Do.
Berkeley Pit	Mont	do	do	Do.
Sierrita	Ariz	Duval Sierrita Corp	do	Do.
Tyrone	N. Mex	Phelps Dodge Corp	do	Do.
Erie Commercial (Hoyt Lake)	Minn	Pickands Mather & Co	Iron ore	Do.
Minntac	do	United States Steel Corp	do	Do.
Morenci	Ariz	Phelps Dodge Corp	Copper	Do.
Mitchell Pit	Minn	Reserve Mining Company	Iron ore	Do.
Shirley Basin	Wyo	Utah International, Inc	Uranium	Do.
Pima	Ariz	Pima Mining Company	Copper	Do.
Lucky Mc	Wyo	Utah International, Inc	Uranium	Do.
Ray Pit	Ariz	Kennecott Copper Corp	Copper	Do.
Ruth	Nev	do	do	Do.
Questa	N. Mex	Molybdenum Corp. of America	Molybdenum	Do.
Mission	Ariz	American Smelting & Refining Co.	Copper	Do.
New Cornelia	do	Phelps Dodge Corp	do	Do.
Eagle Mountain	Calif	Kaiser Steel Corp	Iron ore	Do.
Chino	N. Mex	Kennecott Copper Corp	Copper	Do.
Yerington	Nev	The Anaconda Company	do	Do.
San Manuel	Ariz	Magma Copper Co	do	Caving.
Inspiration	do	Inspiration Consolidated Copper Corp	do	Open pit.
Highland	Wyo	Exxon Corp	Uranium	Do.
Empire	Mich	Cleveland-Cliffs Iron Co	Iron ore	Do.
Republic	do	do	do	Do.
		NONMETALS		
Kingsford	Fla	International Minerals & Chemical Corp.	Phosphate rock	Open pit.
Haynsworth	do	American Cyanamid Co	do	Do.
Noralyn	do	International Minerals & Chemical Corp	do	Do.
Suwannee	do	Occidental Petroleum Corp	do	Do.
Rockland	do	United States Steel Corp	do	Do.
Ft. Meade	do	Mobil Oil Corp	do	Do.
Payne Creek	do	Continental Oil Co	do	Do.
Bonny Lake	do	W. R. Grace & Co	do	Do.
Palmetto	do	Continental Oil Co	do	Do.
Clear Spring	do	International Minerals & Chemical Corp.	do	Do.
Tampa Agricultural Chemical Operations.	do	Gardinier Inc	do	Do.
Nichols	do	Mobil Oil Corp	do	Do.
Boron	Calif	U. S. Borax & Chemical Corp.	Boron minerals	Do.
Tenoroc	Fla	Borden Inc	do	Do.
Lee Creek	N. C	Texas Gulf Inc	do	Do.
Silver City	Fla	Swift Agricultural Chemical Corp.	do	Do.
Calcite	Mich	United States Steel Corp	Crushed and broken stone.	Do.
Saddle Creek	Fla	Continental Oil Co	Phosphate rock	Do.
Gay	Idaho	J. R. Simplot Co	do	Do.
Watson	Fla	Swift Agricultural Chemicals Corp.	do	Do.
Thornton	Ill	General Dynamics Corp	Crushed and broken stone.	Do.
Stone Port	Mich	Presque Isle Corp	do	Do.
Pennsuco	Fla	Maule Industries, Inc	do	Do.
Zonolite	Mont	W. R. Grace & Co	Vermiculite	Do.
Westvaco	Wyo	FMC Corporation	Sodium carbonate	Open 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, by commodity, in 1972

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	[2] 2,560	[2] 1,810	[2] 1.4:1	W	W	W	2,560	1,810	1.4:1
Copper	Thousand short tons	232,000	1,340	173.4:1	34,600	297	116.5:1	267,000	1,640	163.0:1
Gold:										
Lode	Thousand troy ounces	3,400	385	8.8:1	1,690	499	3.4:1	5,090	885	5.8:1
Placer	do	1,330	13	104.0:1	--	--	--	1,330	13	104.0:1
Iron ore	Thousand long tons	199,000	71,400	2.8:1	11,500	6,430	1.8:1	210,000	77,800	2.7:1
Lead	Thousand short tons	(3)	(3)	6.0:1	9,560	563	17.0:1	9,560	563	17.0:1
Mercury	Thousand flasks	53	5	11.7:1	31	3	11.8:1	84	7	11.7:1
Silver	Thousand troy ounces	68	93	0.7:1	580	11,100	0.1:1	648	11,200	0.1:1
Titanium: Ilmenite	Thousand short tons	26,200	726	36.0:1	--	--	--	26,200	726	36.0:1
Uranium	do	3,810	7	516.9:1	2,580	5	481.9:1	6,390	13	502.2:1
Zinc	do	88	2	43.1:1	8,130	346	23.5:1	8,220	348	23.6:1
NONMETALS										
Asbestos	do	[2] 2,300	[2] 132	[2] 17.4:1	W	W	W	2,300	132	17.4:1
Barite	do	4,160	748	5.6:1	116	158	0.7:1	4,270	906	4.7:1
Clays	do	55,200	55,200	1.0:1	886	886	1.0:1	56,100	56,100	1.0:1
Diatomite	do	576	576	1.0:1	--	--	--	576	576	1.0:1
Feldspar	do	1,560	646	2.4:1	--	--	--	1,560	646	2.4:1
Fluorspar	do	120	26	4.7:1	534	225	2.4:1	654	250	2.6:1
Gypsum	do	9,820	9,740	1.0:1	2,720	2,580	1.0:1	12,500	12,300	1.0:1
Mica (scrap)	do	139	124	1.1:1	--	--	--	139	124	1.1:1
Perlite	do	[2] 545	[2] 545	[2] 1.0:1	W	W	W	545	545	1.0:1
Phosphate rock	do	128,000	40,600	3.2:1	240	240	1.0:1	128,000	40,800	3.1:1
Potassium salts	do	--	--	--	17,300	2,300	7.5:1	17,300	2,300	7.5:1
Pumice	do	3,810	3,810	1.0:1	--	--	--	3,810	3,810	1.0:1
Salt	do	447	278	1.6:1	14,300	14,000	1.0:1	14,800	14,300	1.0:1
Sand and gravel	do	913,000	913,000	1.0:1	--	--	--	913,000	913,000	1.0:1
Sodium carbonate (natural)	do	--	--	--	5,130	2,940	1.7:1	5,130	2,940	1.7:1
Stone:										
Crushed and broken	do	890,000	887,000	1.0:1	35,500	35,300	1.0:1	925,000	922,000	1.0:1
Dimension	do	[e] 2,750	1,260	2.2:1	2	2	1.0:1	2,750	1,260	2.2:1
Talc, soapstone, pyrophyllite	do	1,490	641	2.3:1	704	467	1.5:1	2,190	1,110	2.0:1
Tripoli	do	[2] 88	[2] 88	[2] 1.0:1	W	W	W	88	88	1.0:1
Vermiculite	do	4,270	337	12.7:1	--	--	--	4,270	337	12.7:1

[e] Estimate. W Withheld to avoid disclosing individual company confidential data, included with "Surface."
[1] Data may not add to totals shown because of independent rounding.
[2] Includes underground data; the Bureau of Mines is not at liberty to publish separately.
[3] Less than ½ unit.

Table 11.—Material handled per unit of marketable product at surface and underground mines in the United States, by commodity, in 1972

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: Total material handled (thousand short tons)[1]	Total: Marketable product, units[1]	Total: Ratio of units of material handled to units of marketable product
METALS										
Bauxite	Thousand long tons	[2] 11,800	[2] 1,810	6.5:1	W	W	W	11,800	1,810	6.5:1
Copper	Thousand short tons	920,000	1,340	663.6:1	35,400	297	118.8:1	955,000	1,640	564.6:1
Gold:										
Lode	Thousand troy ounces	19,500	385	50.6:1	1,910	499	3.8:1	21,500	885	24.2:1
Placer	do	1,430	13	110.9:1	(3)	--	--	1,430	13	110.9:1
Iron ore	Thousand long tons	364,000	71,400	5.1:1	12,900	6,430	2.0:1	377,000	77,800	4.8:1
Lead	Thousand short tons	102	(3)	1.0:1	10,000	563	17.8:1	10,100	563	17.8:1
Mercury	Thousand flasks	105	5	23.0:1	34	3	12.0:1	138	7	19.0:1
Silver	Thousand troy ounces	100	93	0.8:1	749	11,100	0.1:1	849	11,200	0.1:1
Titanium: Ilmenite	Thousand short tons	27,000	726	37.1:1	--	--	--	27,000	726	37.1:1
Uranium	Short tons	175,000	7,363	23.3:1	3,350	5,358	0.6:1	178,000	12,721	13.8:1
Zinc	Thousand short tons	19	2	9.3:1	9,130	346	26.3:1	9,150	348	26.2:1
NONMETALS										
Asbestos	do	[2] 3,060	[2] 132	[2] 23.2:1	W	W	W	3,060	132	23.2:1
Barite	do	6,260	748	8.4:1	130	158	0.8:1	6,390	906	7.1:1
Clays	do	[e] 103,000	55,200	1.9:1	[e] 899	886	1.0:1	104,000	56,100	1.9:1
Diatomite	do	3,100	576	5.4:1	--	--	--	3,100	576	5.4:1
Feldspar	do	1,770	646	2.7:1	--	--	--	1,770	646	2.7:1
Fluorspar	do	125	26	4.7:1	529	225	2.4:1	655	250	2.6:1
Gypsum	do	25,500	9,740	2.6:1	2,720	2,580	1.1:1	28,200	12,300	2.3:1
Mica (scrap)	do	936	124	7.6:1	1	--	--	937	124	7.6:1
Perlite	do	684	545	1.3:1	W	W	W	684	545	1.3:1
Phosphate rock	do	382,000	40,600	9.4:1	241	240	1.0:1	382,000	40,800	9.4:1
Potassium salts	do	--	--	--	18,600	2,300	8.1:1	18,600	2,300	8.1:1
Pumice	do	3,870	3,810	1.0:1	--	--	--	3,870	3,810	1.0:1
Salt	do	425	278	1.5:1	13,800	14,000	1.0:1	14,200	14,300	1.0:1
Sand and gravel	do	913,000	913,000	1.0:1	--	--	--	913,000	913,000	1.0:1
Sodium carbonate (natural)	do	--	--	--	8,210	2,940	2.8:1	8,210	2,940	2.8:1
Stone:										
Crushed and broken	do	955,000	887,000	1.1:1	35,700	35,300	1.0:1	991,000	922,000	1.1:1
Dimension	do	[e] 4,200	1,260	3.3:1	2	2	1.0:1	4,200	1,260	3.3:1
Talc, soapstone, pyrophyllite	do	2,810	641	4.4:1	732	467	1.6:1	3,540	1,110	3.2:1
Tripoli	do	[2] 103	[2] 88	[2] 1.2:1	W	W	W	103	88	1.2:1
Vermiculite	do	6,770	337	20.1:1	--	--	--	6,770	337	20.1:1

[e] Estimate. W Withheld to avoid disclosing individual company confidential data, included with "Surface."
[1] Data may not add to totals shown because of independent rounding.
[2] Includes underground data; the Bureau of Mines is not at liberty to publish separately.
[3] Less than ½ unit.

Table 12.—Mining methods used in open-pit mining, by commodity, in 1972

(Percent)

Commodity	Total material handled: Preceded by drilling and blasting	Total material handled: Not preceded by drilling and blasting[1]	Commodity	Total material handled: Preceded by drilling and blasting	Total material handled: Not preceded by drilling and blasting[1]
METALS			NONMETALS—Continued		
Bauxite	91	9	Barite	9	91
Beryllium	--	100	Boron minerals	100	--
Copper	86	14	Clays	--	100
Gold:			Diatomite	--	100
Lode	96	4	Feldspar	71	29
Placer	--	100	Fluorspar	95	5
Iron ore	88	12	Graphite	100	--
Lead	44	56	Greensand marl	--	100
Mercury	15	85	Gypsum	83	17
Molybdenum	96	4	Iron oxide pigments (crude)	--	100
Nickel	20	80	Kyanite	100	--
Platinum-group metals	--	100	Magnesite	100	--
Rare-earth metals	100	--	Mica	3	97
Silver	84	16	Millstone	98	2
Tin	--	100	Olivine	41	59
Titanium: Ilmenite	8	92	Perlite	37	63
Tungsten	11	89	Phosphate rock	2	98
Uranium	8	92	Pumice	1	99
Vanadium	20	80	Salt	6	94
Zinc	100	--	Sand and gravel	--	100
NONMETALS			Stone:		
Abrasives:			Crushed and broken	95	5
Abrasive stone	58	42	Dimension	20	80
Emery	100	--	Talc, soapstone, pyrophyllite	66	34
Garnet	63	37	Vermiculite	62	38
Tripoli	96	4			
Aplite	16	84	Total	30	70
Asbestos	84	16			

[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, by method

Method	Metals: Feet	Metals: percent[2] of total	Nonmetals: Feet	Nonmetals: percent[2] of total	Total[1]: Feet	Total[1]: percent[2] of total
1971						
Shaft and winze sinking	19,100	0.1	1,770	0.2	20,900	0.1
Raising	160,000	.6	4,320	.5	165,000	.6
Drifting and crosscutting	889,000	3.3	22,900	2.8	912,000	3.3
Diamond drilling	1,890,000	7.1	142,000	17.3	2,030,000	7.4
Churn drilling	121,000	.4	4,720	.6	126,000	.5
Rotary drilling	15,100,000	56.5	284,000	34.6	15,400,000	55.8
Percussion drilling	7,470,000	27.9	327,000	40.0	7,800,000	28.2
Trenching	117,000	.4	5,250	.6	123,000	.4
Other	988,000	3.7	27,600	3.4	1,020,000	3.7
Total[1]	26,800,000	100.0	819,000	100.0	27,600,000	100.0
1972						
Shaft and winze sinking	15,500	.1	1,950	.4	17,500	.1
Raising	136,000	.5	6,530	1.3	142,000	.5
Drifting and crosscutting	766,000	3.1	42,700	8.3	808,000	3.2
Diamond drilling	1,740,000	7.1	107,000	20.8	1,850,000	7.4
Churn drilling	96,400	.4	--	--	96,400	.4
Rotary drilling	13,000,000	53.0	297,000	57.6	13,300,000	53.1
Percussion drilling	8,350,000	34.1	27,300	5.3	8,370,000	33.5
Trenching	62,800	.3	440	.1	63,200	.3
Other	356,000	1.4	32,400	6.2	389,000	1.5
Total[1]	24,500,000	100.0	516,000	100.0	25,000,000	100.0

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

Table 14.—Exploration and development by method and selected metals and nonmetals, in 1972

(Feet)

Commodity	Shaft and winze sinking	Raising	Drifting and cross-cutting	Trenching	Diamond drilling	Churn drilling	Rotary drilling	Percussion drilling	Other	Total [1]
METALS										
Copper	7,610	68,400	149,000	12,400	785,000	6,710	205,000	1,870,000	2,100	3,100,000
Gold	1,950	12,400	36,200	6,290	47,400	1,120	495,000	4,630,000	886	5,230,000
Iron ore	243	3,900	71,800	--	84,900	--	147,000	5,180	295	313,000
Lead	430	11,300	49,400	27,700	242,000	28,300	24,800	23,400	71,500	479,000
Mercury	--	40	735	40	--	--	15,500	--	93	16,400
Silver	609	5,440	16,700	2,560	14,900	--	124	22,000	150	62,600
Tungsten	50	3,350	8,440	8,370	18,300	--	--	--	15	38,600
Uranium	2,610	16,600	269,000	70	170,000	2,330	11,400,000	1,140,000	246,000	13,300,000
Zinc	1,770	13,500	86,500	300	243,000	45	740	629,000	10,700	985,000
Other [2]	259	468	78,000	5,090	132,000	57,800	662,000	35,000	24,300	995,000
Total [1]	15,500	136,000	766,000	62,800	1,740,000	96,400	13,000,000	8,350,000	356,000	24,500,000
NONMETALS										
Asbestos	--	--	--	--	6,870	--	--	--	--	6,870
Barite	--	190	1,010	--	--	--	18,000	20,400	29,300	68,900
Fluorspar	1,450	5,020	38,900	--	92,600	--	--	--	--	138,000
Gypsum	368	--	--	--	2,410	--	123,000	5,000	--	131,000
Phosphate rock	--	--	106	60	3,330	--	107,000	--	--	111,000
Talc, soapstone, pyrophyllite	87	1,320	2,100	--	1,400	--	--	--	--	4,900
Other [3]	42	--	550	380	594	--	48,500	1,900	3,100	55,100
Total [1]	1,950	6,530	42,700	440	107,000	--	297,000	27,300	32,400	516,000
Grand total [1]	17,500	142,000	808,000	63,200	1,850,000	96,400	13,300,000	8,370,000	389,000	25,000,000

[1] Data may not add to totals shown because of independent rounding.
[2] Antimony, bauxite, beryllium, molybdenum, nickel, and titanium (ilmenite).
[3] Abrasive stone, diatomite, feldspar, mica, millstone, pumice, salt, tripoli, and vermiculite.

Table 15.—Exploration and development by method and State, in 1972

(Feet)

State	Shaft and winze sinking	Raising	Drifting and cross-cutting	Trenching	Diamond drilling	Churn drilling	Rotary drilling	Percussion drilling	Other	Total[1]
Alabama	--	--	--	--	74,100	57,800	584,000	--	--	716,000
Alaska	--	900	3,100	1,440	8,040	463	--	100	800	14,800
Arizona	7,160	57,200	111,000	11,600	414,000	6,310	86,000	420,000	2,030	1,120,000
Arkansas	--	190	31,000	--	--	--	139,000	--	13,800	184,000
California	475	3,790	9,400	1,350	27,000	200	1,090	1,370	4,220	48,900
Colorado	1,760	9,900	87,800	6,670	216,000	2,330	259,000	236,000	115,000	935,000
Florida	--	--	--	--	--	--	81,600	--	--	81,600
Georgia	--	--	--	--	2,620	--	11,000	--	--	13,600
Idaho	640	12,200	36,600	1,300	59,600	--	27,300	7,100	1,370	146,000
Illinois	866	3,110	33,000	--	79,200	--	--	--	--	116,000
Indiana	368	--	--	--	--	--	--	--	--	368
Iowa	--	--	--	--	--	--	2,400	--	--	2,400
Maine	--	--	72	--	34,100	--	--	413,000	--	447,000
Michigan	--	--	7,540	--	25,600	--	--	4,720	--	37,900
Minnesota	--	--	--	--	73,000	--	--	1,500	--	75,000
Missouri	358	2,190	65,300	27,400	194,000	28,000	20,000	--	98,000	436,000
Montana	158	9,270	22,800	1,140	50,200	--	86,400	1,420,000	10	1,590,000
Nevada	887	698	4,480	10,400	31,600	500	561,000	42,000	500	653,000
New Jersey	--	--	--	--	--	--	--	--	9,450	9,450
New Mexico	1,530	15,600	255,000	1,090	49,600	--	3,610,000	792,000	119,000	4,840,000
New York	87	6,000	25,100	--	23,000	--	--	--	--	54,200
North Carolina	--	--	--	--	--	--	9,000	--	--	9,000
North Dakota	--	--	--	--	--	--	30,500	--	--	30,500
Oklahoma	--	--	--	380	--	401	5,080	--	--	5,860
Oregon	--	60	335	100	430	--	11,000	--	93	12,000
Pennsylvania	553	2,540	15,000	--	1,300	--	--	38,600	--	58,000
South Dakota	950	10,900	30,600	--	43,000	--	262,000	4,620,000	--	4,970,000
Tennessee	575	1,130	28,800	--	206,000	--	4,140	130,000	173	871,000
Texas	--	--	--	--	--	--	2,440,000	40,000	--	2,480,000
Utah	1,120	4,060	33,800	40	152,000	--	459,000	156,000	13,700	820,000
Vermont	--	450	250	--	--	--	--	--	--	700
Virginia	--	1,620	2,070	--	16,800	--	--	2,000	--	22,500
Washington	5	154	5,600	300	36,000	300	124	--	9,940	52,100
Wisconsin	--	--	--	--	19,600	--	3,420	--	--	23,000
Wyoming	--	--	--	--	8,470	--	4,580,000	48,300	--	4,630,000
Total[1]	17,500	142,000	808,000	63,200	1,850,000	96,400	13,300,000	8,370,000	389,000	25,000,000

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

Table 16.—Total material (ore and waste) produced by exploration and development in the United States, by commodity and State, in 1972

(Thousand short tons)

	Shaft and winze sinking	Raising	Drifting and crosscutting	Trenching	Stripping	Total [1]
COMMODITY						
METALS						
Bauxite	--	--	230	--	9,160	9,390
Copper	77	193	945	25	311,000	312,000
Gold:						
Lode	9	46	129	10	12	205
Placer	--	--	(2)	3	16	19
Iron ore	5	9	836	--	114,000	115,000
Lead	4	33	326	162	101	626
Mercury	--	(2)	2	(2)	3	5
Silver	3	35	118	18	38	212
Tungsten	1	12	66	45	8	132
Uranium	25	43	1,010	(2)	167,000	168,000
Zinc	21	36	710	1	8	776
Other [3]	(2)	3	533	13	32,000	32,600
Total metals [1]	145	409	4,910	278	633,000	639,000
NONMETALS						
Barite	--	1	5	--	268	274
Fluorspar	11	15	239	--	6	272
Gypsum	3	--	--	--	15,700	15,700
Perlite	--	--	--	--	35	35
Phosphate rock	--	--	(2)	(2)	224,000	224,000
Salt	--	--	11	--	3	14
Talc, soapstone, pyrophyllite	1	3	9	--	1,320	1,340
Other [4]	--	--	--	1	5,990	5,990
Total nonmetals [1]	16	19	265	2	247,000	247,000
Grand total [1]	160	428	5,180	279	880,000	886,000
STATE						
Alabama	--	--	--	--	3,240	3,240
Alaska	--	8	15	3	11	37
Arizona	74	136	766	24	185,000	186,000
Arkansas	--	1	236	--	11,600	11,800
California	2	13	69	5	4,100	4,180
Colorado	12	27	712	17	325	1,100
Florida	--	--	--	--	184,000	184,000
Georgia	--	--	--	--	51	51
Idaho	5	55	231	10	17,000	17,300
Illinois	7	11	211	--	--	228
Indiana	3	--	--	--	--	3
Iowa	--	--	--	--	3,780	3,780
Kansas	--	--	--	--	38	38
Michigan	--	--	28	--	23,900	24,000
Minnesota	--	--	--	--	86,300	86,300
Missouri	6	8	829	160	--	1,000
Montana	1	49	104	4	49,100	49,200
Nevada	6	2	17	51	32,400	32,400
New Mexico	15	36	947	2	87,200	88,200
New York	1	11	123	--	1,190	1,320
North Carolina	--	--	--	--	9,890	9,890
Oregon	--	(2)	1	1	385	387
Pennsylvania	13	5	110	--	1,200	1,330
South Dakota	5	39	111	--	12	167
Tennessee	4	2	359	--	3,750	4,120
Texas	--	--	--	--	16,100	16,100
Utah	7	22	196	1	10,100	10,400
Vermont	--	1	1	--	590	592
Virginia	--	2	12	--	1,720	1,730
Washington	(2)	(2)	99	1	105	205
Wyoming	--	--	--	--	145,000	145,000
Other [5]	--	--	1	--	1,550	1,550
Total [1]	160	428	5,180	279	880,000	886,000

[1] Data may not add to totals shown because of independent rounding.
[2] Less than ½ unit.
[3] Antimony, beryllium, molybdenum, nickel, titanium (ilmenite), and vanadium.
[4] Abrasive stone, aplite, asbestos, boron minerals, diatomite, feldspar, graphite, mica (scrap), pumice, and tripoli.
[5] Connecticut, Maine, and Oklahoma.

Table 17.—U.S. consumption of explosives

(Thousand pounds)

Year	Coal mining	Metal mining	Quarrying and nonmetal mining	Total mineral industry	Other	Total industrial
1968	684,166	403,444	397,998	1,485,608	462,129	1,947,737
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

Statistical Summary

By Staff, Office of Technical Data Services—Mineral Supply

This chapter is a summarization of mineral production data for the United States, its island possessions, the Canal Zone, and the Commonwealth of Puerto Rico. Also included 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. More detailed data are contained in the commodity chapters of volume I and in the State chapters of volume II of this edition of the Minerals Yearbook.

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 case 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 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 mineral production [1] in the United States, by mineral group

(Millions)

Year	Mineral fuels	Nonmetals (except fuels)	Metals	Total [2]
1968	$16,820	$5,449	$2,698	$24,966
1969	17,965	5,624	3,333	26,921
1970	20,152	r 5,712	3,928	r 29,792
1971 r	21,247	6,058	3,403	30,708
1972	22,084	6,492	3,641	32,217

r Revised.

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

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

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

Mineral	1969 Quantity	1969 Value (thousands)	1970 Quantity	1970 Value (thousands)	1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
MINERAL FUELS								
Asphalt and related bitumens (native): Bituminous limestone and sandstone and gilsonite ____ short tons	1,918,748	$8,561	1,980,562	$8,879	1,668,928	$8,291	1,995,374	$10,303
Carbon dioxide, natural e ____ thousand cubic feet	1,194,836	144	1,109,530	191	1,271,995	216	1,228,741	165
Coal:								
Bituminous and lignite [2] ____ thousand short tons	560,505	2,795,509	602,932	3,772,662	552,192	3,901,496	595,386	4,561,983
Pennsylvania anthracite ____ do	10,473	100,769	9,729	105,341	8,727	108,469	7,106	85,251
Helium:								
Crude ____ million cubic feet	3,993	46,843	3,953	46,820	3,988	47,856	3,462	41,544
Grade A ____ do	760	21,599	647	17,405	577	14,539	627	15,603
Natural gas ____ do	20,698,240	3,455,615	21,920,642	3,745,680	22,493,012	r 4,085,482	22,531,698	4,203,236
Natural gas liquids:								
Natural gasoline and cycle products thousand 42-gallon barrels	201,784	603,084	206,305	603,024	200,181	616,657	193,480	604,423
LPG ____ do	378,457	498,927	399,611	672,088	417,634	769,397	444,736	847,810
Peat ____ thousand short tons	566	7,055	526	5,986	600	7,011	607	7,112
Petroleum (crude) ____ thousand 42-gallon barrels	3,371,751	10,426,680	3,517,450	11,173,726	3,453,914	11,692,998	3,455,368	11,706,510
Total mineral fuels	XX	17,965,000	XX	20,152,000	XX	r 21,247,000	XX	22,084,000
NONMETALS (EXCEPT FUELS)								
Abrasive stones [3] ____ short tons	3,311	600	3,055	635	2,349	563	3,241	670
Asbestos ____ do	125,936	10,648	125,314	10,696	130,882	12,174	131,663	13,408
Barite ____ thousand short tons	1,077	15,753	854	12,800	825	13,491	906	14,883
Boron minerals ____ do	1,020	81,261	1,041	86,827	1,047	89,856	1,121	95,882
Bromine ____ thousand pounds	391,883	87,990	349,748	60,560	355,946	61,750	386,864	63,689
Calcium-magnesium chloride ____ short tons	W	W	632,500	15,225	W	W	W	W
Cement:								
Portland ____ thousand short tons	75,366	1,284,600	71,629	1,268,718	75,881	1,421,388	77,973	1,588,290
Masonry ____ do	3,255	69,106	2,978	67,537	3,341	84,556	3,777	100,269
Clays ____ do	58,694	264,415	54,853	267,912	56,666	274,431	59,456	308,022
Diatomite ____ short tons	598,482	36,485	597,636	32,649	535,318	34,392	576,089	37,554
Feldspar ____ do	754,863	8,869	726,069	9,638	742,810	9,969	732,439	10,372
Fluorspar ____ do	182,567	8,411	269,221	13,923	272,071	17,263	250,347	17,315
Garnet (abrasive) ____ do	20,458	1,874	18,837	1,936	18,984	1,934	18,916	1,957
Gem stones e ____	NA	2,390	NA	2,396	NA	2,589	NA	2,728
Gypsum ____ thousand short tons	9,905	38,354	9,436	35,132	10,418	39,057	12,328	48,504
Lime ____ do	20,209	280,736	19,747	286,155	19,591	308,100	20,290	339,304
Magnesium compounds from sea water and brine (except for metal) ____ short tons, MgO equivalent	618,762	53,046	707,874	62,434	668,649	62,322	729,472	63,915
Mica:								
Scrap ____ thousand short tons	133	2,893	119	2,527	127	2,917	160	4,353
Sheet ____ pounds	W	3	--	--	17,005	7	14,280	7
Perlite ____ short tons	471,454	5,100	456,134	4,904	432,208	4,941	544,594	6,231
Phosphate rock ____ thousand short tons	37,725	208,689	38,739	203,218	38,886	203,828	40,831	207,910
Potassium salts ____ thousand short tons, K_2O equivalent	2,804	73,572	2,729	98,123	2,587	100,527	2,659	106,680
Pumice ____ thousand short tons	3,609	5,050	3,036	4,671	r 3,391	r 5,214	3,813	6,539
Pyrites ____ thousand long tons	W	W	W	W	808	7,137	741	6,652

Salt ... thousand short tons	44,245	287,680	45,896	304,759	44,077	303,687	45,022	296,772
Sand and gravel ... do	937,169	1,069,667	943,941	1,115,705	919,593	1,148,969	913,375	1,199,520
Sodium carbonate (natural) ... do	2,513	50,922	2,688	56,320	2,878	60,774	3,218	71,689
Sodium sulfate (natural) ... do	672	12,427	602	10,932	688	11,008	701	11,396
Stone [4] ... do	862,895	1,424,694	874,512	1,474,917	r 876,123	r 1,594,065	923,852	1,683,332
Sulfur: Frasch process mines ... thousand long tons	6,551	176,659	6,419	151,779	r 6,738	r 117,894	7,613	132,385
Talc, soapstone, and pyrophyllite ... short tons	1,029,238	7,508	1,027,929	7,773	1,037,297	7,634	1,107,404	7,835
Tripoli ... do	84,673	734	68,105	520	75,134	569	87,864	797
Vermiculite ... thousand short tons	310	6,805	285	6,501	301	7,198	337	8,092
Value of items that cannot be disclosed: Aplite, brucite (1969–71), natural and slag cement, emery, graphite, iodine, kyanite, lithium minerals, magnesite, greensand marl, olivine, staurolite, wollastonite, and values of nonmetal items indicated by symbol W	XX	46,941	XX	r 34,401	XX	r 47,358	XX	39,730
Total nonmetals	XX	5,624,000	XX	r 5,712,000	XX	r 6,058,000	XX	6,492,000
METALS								
Antimony ore and concentrate ... short tons, antimony content	938	W	1,130	W	1,025	933	489	386
Bauxite ... thousand long tons, dried equivalent	1,843	25,725	2,082	30,070	1,988	28,543	1,812	23,238
Copper (recoverable content of ores, etc.) ... short tons	1,544,579	1,468,400	1,719,657	1,984,484	1,522,183	1,583,071	1,664,840	1,704,796
Gold (recoverable content of ores, etc.) ... troy ounces	1,733,176	71,944	1,743,322	63,439	1,495,108	61,673	1,449,943	84,967
Iron ore, usable (excluding byproduct iron sinter) thousand long tons, gross weight	89,854	929,293	87,176	941,739	77,106	891,002	77,884	950,365
Lead (recoverable content of ores, etc.) ... short tons	509,013	151,635	571,767	178,609	578,550	159,679	618,915	186,046
Manganese ore (35% or more Mn) ... short tons, gross weight	5,630	157	4,737	W	142	W	578	W
Manganiferous ore (5% to 35% Mn) ... do	430,637	W	368,302	W	198,334	W	147,161	W
Mercury ... 76-pound flasks	29,640	14,969	27,296	11,130	r 17,883	r 5,229	7,286	1,590
Molybdenum (content of concentrate) ... thousand pounds	103,009	173,819	110,381	190,077	97,882	164,917	102,197	170,530
Nickel (content of ore and concentrate) ... short tons	17,056	W	15,933	W	17,036	W	16,864	W
Rare-earth metal concentrates ... do	W	W	W	W	17,194	7,538	19,520	8,479
Silver (recoverable content of ores, etc.) thousand troy ounces	41,906	75,040	45,006	79,697	41,564	64,258	37,233	62,737
Titanium concentrate, ilmenite ... short tons, gross weight	893,034	18,636	920,964	18,626	r 713,610	r 15,936	725,728	16,265
Tungsten ore and concentrate ... short tons, 60% WO_3 basis	8,312	18,770	9,785	23,790	7,173	20,184	7,401	18,104
Uranium (recoverable content U_3O_8) ... thousand pounds	23,748	142,161	24,682	149,464	r 24,515	r 151,996	25,758	162,272
Vanadium (recoverable in ore and concentrate) ... short tons	5,577	26,334	5,319	34,923	5,252	37,690	4,887	30,867
Zinc (recoverable content of ores, etc.) ... do	553,124	161,512	534,136	163,650	r 491,407	r 158,234	478,318	169,803
Value of items that cannot be disclosed: Beryllium, cobalt (1969–71), columbium-tantalum concentrate (1969), magnesium chloride for magnesium metal, manganiferous residuum, platinum-group metals (crude), tin (content of concentrates), titanium concentrate (rutile 1972), zircon concentrates, and value of metal items indicated by symbol W	XX	54,180	XX	58,430	XX	51,690	XX	50,664
Total metals	XX	3,333,000	XX	3,928,000	XX	r 3,403,000	XX	3,641,000
Grand total mineral production	XX	26,921,000	XX	r 29,792,000	XX	r 30,708,000	XX	32,217,000

[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. In 1971, value excluded that of Arizona, which is withheld to avoid disclosing individual company confidential data; value included with "Nonmetal items that cannot be disclosed."
[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 1972

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

Table 3.—Minerals produced in the United States and principal producing States in 1972—Continued

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

Table 4.—Value of mineral production in the United States and principal minerals produced in 1972

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	$371,241	21	1.15	Coal, cement, stone, petroleum.
Alaska	286,138	25	.89	Petroleum, natural gas, sand and gravel, coal.
Arizona	1,091,004	8	3.39	Copper, molybdenum, sand and gravel, cement.
Arkansas	241,179	29	.75	Petroleum, bromine, natural gas, stone.
California	1,851,365	3	5.75	Petroleum, cement, natural gas, sand and gravel.
Colorado	425,841	19	1.32	Petroleum, molybdenum, coal, sand and gravel.
Connecticut	33,123	45	.10	Stone, sand and gravel, feldspar, lime.
Delaware	2,871	50	.01	Sand and gravel, magnesium compounds, clays.
Florida	424,287	20	1.32	Phosphate rock, stone, cement, petroleum.
Georgia	258,041	28	.80	Clays, stone, cement, sand and gravel.
Hawaii	28,074	46	.09	Stone, cement, sand and gravel, pumice.
Idaho	106,206	36	.33	Silver, lead, phosphate rock, zinc.
Illinois	769,737	10	2.39	Coal, petroleum, stone, sand and gravel.
Indiana	322,608	22	1.00	Coal, cement, stone, sand and gravel.
Iowa	134,496	31	.42	Cement, stone, sand and gravel, gypsum.
Kansas	584,537	15	1.81	Petroleum, natural gas, natural gas liquids, cement.
Kentucky	976,910	9	3.03	Coal, stone, petroleum, natural gas.
Louisiana	5,411,543	2	16.80	Petroleum, natural gas, natural gas liquids, sulfur.
Maine	22,922	47	.07	Cement, sand and gravel, stone, zinc.
Maryland	115,501	33	.36	Stone, cement, sand and gravel, coal.
Massachusetts	52,428	43	.16	Sand and gravel, stone, lime, clays.
Michigan	694,767	13	2.16	Iron ore, cement, copper, sand and gravel.
Minnesota	659,669	14	2.05	Iron ore, sand and gravel, stone, cement.
Mississippi	260,681	27	.81	Petroleum, natural gas, sand and gravel, cement.
Missouri	451,817	18	1.40	Lead, cement, stone, iron ore.
Montana	307,676	24	.96	Copper, petroleum, sand and gravel, coal.
Nebraska	73,675	41	.23	Petroleum, cement, sand and gravel, stone.
Nevada	181,702	30	.56	Copper, gold, sand and gravel, diatomite.
New Hampshire	10,111	48	.03	Sand and gravel, stone, clays, gem stones.
New Jersey	113,760	34	.35	Stone, sand and gravel, zinc, magnesium compounds.
New Mexico	1,097,292	7	3.41	Petroleum, natural gas, copper, potassium salts.
New York	320,453	23	.99	Cement, stone, salt, sand and gravel.
North Carolina	116,323	32	.36	Stone, sand and gravel, cement, phosphate rock.
North Dakota	98,086	37	.30	Petroleum, coal, sand and gravel, natural gas.
Ohio	724,748	12	2.25	Coal, stone, lime, cement.
Oklahoma	1,210,728	6	3.76	Petroleum, natural gas, natural gas liquids, cement.
Oregon	76,516	40	.24	Sand and gravel, stone, cement, nickel.
Pennsylvania	1,231,485	5	3.82	Coal, cement, stone, sand and gravel.
Rhode Island	4,291	49	.01	Sand and gravel, stone, gem stones.
South Carolina	82,313	39	.26	Cement, stone, sand and gravel, clays.
South Dakota	65,200	42	.20	Gold, sand and gravel, stone, cement.
Tennessee	269,814	26	.84	Coal, stone, cement, zinc.
Texas	7,211,551	1	22.38	Petroleum, natural gas, natural gas liquids, cement.
Utah	542,809	16	1.68	Copper, petroleum, coal, gold.
Vermont	34,868	44	.11	Stone, sand and gravel, asbestos, talc.
Virginia	489,791	17	1.52	Coal, stone, cement, sand and gravel.
Washington	109,806	35	.34	Cement, sand and gravel, stone, coal.
West Virginia	1,430,632	4	4.44	Coal, natural gas, stone, cement.
Wisconsin	89,353	38	.28	Sand and gravel, stone, iron ore, cement.
Wyoming	746,743	11	2.32	Petroleum, sodium carbonate, natural gas, uranium.
Total	32,217,000	--	100.00	

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

State	Area (square miles)	1970 Population (thousands)	Value of mineral production				
			Total (thousands)	Per square mile		Per capita	
				(Thousands)	Rank	(Dollars)	Rank
Alabama	51,609	3,444	$371,241	$7,193	20	$108	20
Alaska	586,412	300	286,138	488	50	954	4
Arizona	113,909	1,771	1,091,004	9,578	14	616	7
Arkansas	53,104	1,923	241,179	4,542	29	125	18
California	158,693	19,953	1,851,365	11,666	12	93	25
Colorado	104,247	2,207	425,841	4,085	32	193	14
Connecticut	5,009	3,032	33,123	6,613	23	11	47
Delaware	2,057	548	2,871	1,396	42	5	49
Florida	58,560	6,789	424,287	7,245	19	62	31
Georgia	58,876	4,590	258,041	4,383	30	56	33
Hawaii	6,450	769	28,074	4,353	31	37	37
Idaho	83,557	713	106,206	1,271	44	149	17
Illinois	56,400	11,114	769,737	13,648	9	69	28
Indiana	36,291	5,194	322,608	8,889	16	62	32
Iowa	56,290	2,824	134,496	2,389	36	48	35
Kansas	82,264	2,247	584,537	7,106	21	260	13
Kentucky	40,395	3,219	976,910	24,184	5	303	12
Louisiana	48,523	3,641	5,411,543	111,525	1	1,486	2
Maine	33,215	992	22,922	690	49	23	41
Maryland	10,577	3,922	115,501	10,920	13	29	40
Massachusetts	8,257	5,689	52,428	6,350	27	9	48
Michigan	58,216	8,875	694,767	11,934	11	78	27
Minnesota	84,068	3,805	659,669	7,847	17	173	15
Mississippi	47,716	2,217	260,681	5,463	28	118	19
Missouri	69,686	4,677	451,817	6,484	24	97	24
Montana	147,138	694	307,676	2,091	38	443	10
Nebraska	77,227	1,483	73,675	954	46	50	34
Nevada	110,540	489	181,702	1,644	39	372	11
New Hampshire	9,304	738	10,111	1,087	45	14	46
New Jersey	7,836	7,168	113,760	14,518	8	16	45
New Mexico	121,666	1,016	1,097,292	9,019	15	1,080	3
New York	49,576	18,237	320,453	6,464	25	18	44
North Carolina	52,586	5,082	116,323	2,212	37	23	42
North Dakota	70,665	618	98,086	1,388	43	159	16
Ohio	41,222	10,652	724,748	17,582	6	68	30
Oklahoma	69,919	2,559	1,210,728	17,316	7	473	9
Oregon	96,981	2,091	76,516	789	48	37	36
Pennsylvania	45,333	11,794	1,231,485	27,165	3	104	22
Rhode Island	1,214	947	4,291	3,535	34	5	50
South Carolina	31,055	2,591	82,313	2,651	35	32	39
South Dakota	77,047	666	65,200	846	47	98	23
Tennessee	42,244	3,924	269,814	6,387	22	69	29
Texas	267,338	11,197	7,211,551	26,975	4	644	6
Utah	84,916	1,059	542,809	6,392	26	513	8
Vermont	9,609	444	34,868	3,629	33	79	26
Virginia	40,817	4,648	489,791	12,000	10	105	21
Washington	68,192	3,409	109,806	1,610	40	32	38
West Virginia	24,181	1,744	1,430,632	59,163	2	820	5
Wisconsin	56,154	4,418	89,353	1,591	41	20	43
Wyoming	97,914	332	746,743	7,627	18	2,249	1
Total	3,615,055	202,455	32,217,000	8,912	--	159	--

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

Mineral	1969 Quantity	1969 Value (thousands)	1970 Quantity	1970 Value (thousands)	1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
ALABAMA								
Cement:[2]								
Masonry ---- thousand short tons	364	$8,520	336	$7,601	349	$8,657	407	$11,221
Portland ---- do	3,107	51,251	3,018	51,114	2,284	42,281	2,360	48,577
Clays ---- do	3,097	7,083	2,748	8,213	[3] 2,915	[3] 6,913	2,850	7,512
Coal (bituminous) ---- do	17,456	130,405	20,560	166,308	17,944	146,180	20,813	200,430
Iron ore (usable) ---- thousand long tons, gross weight	1,125	6,435	W	W	415	2,773	327	1,912
Lime ---- thousand short tons	747	9,870	749	10,286	761	11,454	739	11,751
Natural gas ---- million cubic feet	180	24	627	87	355	54	3,644	1,282
Petroleum (crude) ---- thousand 42-gallon barrels	7,701	20,793	7,263	20,627	7,832	23,496	9,934	30,466
Sand and gravel ---- thousand short tons	8,323	9,427	6,725	8,144	6,674	7,513	6,352	8,530
Stone ---- do	19,854	37,512	[4] 19,982	37,166	17,773	34,413	18,485	42,027
Value of items that cannot be disclosed: Asphalt (native), bauxite, cement (slag), mica (scrap), natural gas liquids, phosphate rock (1969–70), salt, stone (dimension) (1970–72), talc and values indicated by symbol W	XX	3,416	XX	13,699	XX	7,758	XX	7,533
Total	XX	284,736	XX	323,245	XX	291,492	XX	371,241
ALASKA								
Antimony ore and concentrate ---- short tons, antimony content	12	13	63	109	--	--	--	--
Barite ---- thousand short tons	W	W	134	835	102	1,075	W	W
Coal (bituminous) ---- do	667	4,366	549	4,059	698	5,710	668	W
Gem stones	NA	W	NA	W	NA	W	NA	57
Gold (recoverable content of ores, etc.) ---- troy ounces	21,227	881	34,776	1,265	13,012	537	8,639	506
Lead (recoverable content of ores, etc.) ---- short tons	2	1	--	--	--	--	--	--
Natural gas ---- million cubic feet	50,864	12,665	111,576	27,448	121,618	r 17,878	125,596	18,463
Petroleum (crude) ---- thousand 42-gallon barrels	73,953	214,464	83,616	251,684	79,494	257,562	72,893	235,444
Sand and gravel ---- thousand short tons	16,205	18,615	25,825	41,092	23,617	32,806	14,187	15,214
Silver (recoverable content of ores, etc.) ---- thousand troy ounces	2	4	2	4	1	1	([5])	([5])
Stone ---- thousand short tons	1,954	3,902	6,470	10,014	2,658	5,066	652	3,012
Tin ---- long tons	W	W	W	W	17	47	W	W
Value of items that cannot be disclosed: Natural gas liquids (1969, 1971–72), platinum-group metals, uranium (1971–72), and values indicated by symbol W	XX	2,865	XX	1,761	XX	r 2,141	XX	13,442
Total	XX	257,776	XX	338,271	XX	322,823	XX	286,138
ARIZONA								
Clays ---- thousand short tons	120	394	199	454	[3] 119	[3] 84	[3] 134	[3] 355
Coal (bituminous) ---- do	--	--	132	W	1,146	W	W	W
Copper ---- short tons	801,363	761,840	917,918	1,059,277	820,171	852,978	908,612	930,419
Diatomite ---- do	725	W	W	W	W	W	W	W
Gem stones	NA	153	NA	155	NA	160	NA	168
Gold (recoverable content of ores, etc.) ---- troy ounces	110,878	4,603	109,853	3,998	94,038	3,879	102,996	6,036

Gypsum ... thousand short tons	83	424	98	358	W	W	W	W
Helium, high purity ... million cubic feet	56	1,126	62	1,186	W	W	W	W
Iron ore (usable) ... thousand long tons, gross weight	18	136	W	W	[r]16	W	W	W
Lead (recoverable content of ores, etc.) ... short tons	217	65	285	89	859	237	1,763	530
Lime ... thousand short tons	283	5,074	309	4,523	296	4,474	356	6,024
Mercury ... 76-pound flasks	W	W	--	--	--	--	--	--
Molybdenum (content of concentrate) ... thousand pounds	12,699	20,947	15,672	26,700	22,684	39,872	27,216	46,791
Natural gas (marketed) ... million cubic feet	1,136	199	1,101	188	868	153	W	W
Petroleum (crude) ... thousand 42-gallon barrels	2,433	7,056	1,784	5,281	1,236	3,918	993	3,226
Pumice ... thousand short tons	910	814	824	627	949	625	915	722
Sand and gravel ... do	16,744	18,224	17,822	19,804	19,791	24,391	24,842	32,420
Silver (recoverable content of ores, etc.) ... thousand troy ounces	6,141	10,997	7,330	12,981	6,170	9,538	6,653	11,210
Stone ... thousand short tons	2,827	5,812	3,511	7,094	2,873	5,848	4,638	8,018
Tungsten ore and concentrate ... short tons, 60% WO_3 basis	1	2	W	W	W	W	W	W
Uranium (recoverable content U_3O_8) ... thousand pounds	W	W	--	--	--	--	--	--
Zinc (recoverable content of ores, etc.) ... short tons	9,039	2,639	9,618	2,947	7,761	2,499	10,111	3,589
Value of items that cannot be disclosed: Asbestos, cement, clays (bentonite, 1971; fire, 1972), feldspar, fluorspar (1971–72), mica (scrap), perlite, pyrites, vanadium (1969), vermiculite (1969), and values indicated by symbol W	XX	18,957	XX	21,105	XX	32,364	XX	41,496
Total	XX	859,462	XX	1,166,767	XX	981,020	XX	1,091,004
ARKANSAS								
Barite ... thousand short tons	210	4,616	168	3,721	W	W	W	W
Bauxite ... thousand long tons, dried equivalent	1,755	24,706	1,869	26,293	1,781	24,979	1,634	21,010
Bromine and bromine in compounds ... thousand pounds	145,100	28,287	W	W	W	W	W	W
Clays ... thousand short tons	992	2,426	1,014	2,902	[3]936	[3]1,499	[3]885	[3]990
Coal (bituminous) ... do	228	1,802	268	2,225	276	2,848	428	4,676
Gem stones	NA	24	NA	25	NA	30	NA	32
Lime ... thousand short tons	184	2,748	186	2,680	157	2,313	150	2,456
Natural gas ... million cubic feet	169,257	26,743	181,351	29,560	172,154	29,426	166,522	28,808
Natural gas liquids:								
Natural gasoline and cycle products thousand 42-gallon barrels	692	2,049	643	1,824	517	1,686	261	854
LPG ... do	1,279	2,098	1,205	2,482	1,035	2,650	546	1,420
Petroleum (crude) ... do	18,049	51,079	18,035	51,760	18,263	56,805	18,519	58,335
Sand and gravel ... thousand short tons	12,674	14,949	13,301	16,036	11,630	15,603	11,574	16,558
Stone ... do	16,463	23,134	15,284	22,786	[r]17,647	[r]28,776	16,317	25,020
Value of items that cannot be disclosed: Abrasive stones, cement, clays (kaolin), gypsum, mercury (1970–71), soapstone, tripoli, vanadium, and values indicated by symbol W	XX	23,465	XX	63,331	XX	79,703	XX	81,020
Total	XX	208,126	XX	225,625	XX	[r]246,318	XX	241,179
CALIFORNIA								
Antimony ore and concentrate ... short tons, antimony content	--	--	4	10	--	--	--	--
Asbestos ... short tons	75,828	5,956	78,966	6,332	87,144	7,806	90,967	8,673
Barite ... thousand short tons	W	W	W	W	W	W	4	34
Boron minerals ... do	1,020	81,261	1,041	86,827	1,047	89,856	1,121	95,882
Cement: Portland ... do	9,477	170,612	9,306	173,126	9,117	169,921	9,086	182,308
Clays ... do	2,993	7,443	2,824	6,506	[3]2,822	[3]7,103	2,706	7,387

See footnotes at end of table.

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

Mineral	1969 Quantity	1969 Value (thousands)	1970 Quantity	1970 Value (thousands)	1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
CALIFORNIA—Continued								
Copper (recoverable content of ores, etc.) short tons	1,129	$1,073	2,308	$2,663	515	$536	598	$612
Gem stones	NA	200	NA	200	NA	205	NA	215
Gold (recoverable content of ores, etc.) troy ounces	7,904	328	4,999	182	2,966	122	3,974	233
Gypsum thousand short tons	1,210	3,339	1,132	3,271	1,352	3,884	1,525	4,965
Lead (recoverable content of ores, etc.) short tons	2,518	750	1,772	553	2,284	630	1,153	347
Lime thousand short tons	585	9,666	572	9,911	630	10,846	608	13,059
Magnesium compounds from seawater and bitterns (partly estimated) short tons, MgO equivalent	76,220	7,143	73,726	7,489	152,918	16,836	175,654	18,421
Mercury 76-pound flasks	18,480	9,333	18,593	7,582	r 13,489	r 3,944	5,788	1,263
Natural gas million cubic feet	677,689	207,440	649,117	208,367	612,629	199,717	487,278	179,318
Natural gas liquids:								
Natural gasoline and cycle products thousand 42-gallon barrels	12,954	39,944	11,993	38,478	11,045	35,545	8,468	27,664
LPG do	8,238	17,646	7,051	16,006	6,755	16,482	5,847	15,962
Peat thousand short tons	11	106	10	W	12	W	29	620
Perlite do	11,419	105	W	W	W	W	W	W
Petroleum (crude) thousand 42-gallon barrels	375,291	920,060	372,191	945,365	358,484	975,076	347,022	940,430
Pumice thousand short tons	866	1,229	499	832	699	1,179	731	1,507
Salt do	1,895	W	1,656	15,053	1,887	21,142	1,621	14,860
Sand and gravel do	124,718	155,883	140,259	174,221	115,468	157,683	117,288	162,619
Silver (recoverable content of ores, etc.) thousand troy ounces	492	881	451	799	444	686	175	296
Stone thousand short tons	38,033	57,757	46,399	66,950	43,336	86,255	37,213	65,811
Talc, soapstone and pyrophyllite short tons	145,158	2,329	184,660	2,545	153,227	2,084	155,155	1,186
Zinc (recoverable content of ores, etc.) do	3,327	971	3,514	1,077	3,003	967	1,202	427
Value of items that cannot be disclosed: Bromine, calcium-magnesium chloride, carbon dioxide, cement (masonry, 1971–72), coal (lignite), diatomite, feldspar, iron ore, lithium minerals, molybdenum, phosphate rock (1969–70), potassium salts, rare-earth metal concentrates, sodium carbonate and sulfate, tungsten concentrate, wollastonite (1969), and values indicated by symbol W	XX	143,208	XX	125,337	XX	112,218	XX	107,266
Total	XX	1,844,663	XX	1,899,682	XX	r 1,920,723	XX	1,851,365
COLORADO								
Beryllium concentrate short tons	46	W	W	W	W	W	W	W
Carbon dioxide, natural thousand cubic feet	175,787	30	W	W	W	W	W	W
Clays thousand short tons	732	1,619	[3] 637	[3] 1,503	625	1,334	747	1,533
Coal (bituminous) do	5,530	29,121	6,025	35,243	5,337	33,813	5,522	35,637
Copper (recoverable content of ores, etc.) short tons	3,598	3,421	3,749	4,326	3,938	4,096	3,944	4,039
Feldspar do	r 407	3	r 477	3	r 571	4	W	W
Gem stones	NA	122	NA	120	NA	125	NA	131
Gold (recoverable content of ores, etc.) troy ounces	25,777	1,070	37,114	1,351	42,031	1,734	61,100	3,580
Gypsum thousand short tons	94	339	W	W	W	W	W	W
Lead (recoverable content of ores, etc.) short tons	21,767	6,484	21,855	6,827	25,746	7,106	31,346	9,423

Lime____thousand short tons__	127	2,449	119	1,613	193	3,039	187	4,070
Mica, sheet____pounds__	--	--	--	--	8,300	4	14,280	7
Molybdenum____thousand pounds__	62,411	105,346	W	W	W	W	W	W
Natural gas____million cubic feet__	118,754	17,219	105,804	15,553	108,537	16,932	116,949	19,297
Natural gas liquids:								
Natural gasoline and cycle products thousand 42-gallon barrels__	1,076	2,798	745	1,937	929	2,462	1,245	3,349
LPG____do____	1,782	2,762	1,542	2,529	1,653	3,190	1,749	3,673
Peat____thousand short tons__	26	160	34	210	28	156	39	210
Petroleum (crude)____thousand 42-gallon barrels__	28,294	88,277	24,723	78,619	27,391	92,855	32,015	109,171
Pumice____thousand short tons__	42	232	50	268	62	W	59	W
Pyrites____thousand long tons__	24	120	W	W	W	W	W	W
Sand and gravel____thousand short tons__	19,877	27,266	22,261	24,190	27,000	30,155	28,318	34,631
Silver (recoverable content of ores, etc.) thousand troy ounces__	2,599	4,653	2,933	5,194	3,390	5,241	3,664	6,174
Stone____thousand short tons__	2,245	5,079	3,552	8,076	3,785	7,933	4,507	9,599
Tin (content of concentrate)____long tons__	44	119	W	W	W	W	W	W
Tungsten concentrate____short tons, 60% WO_3 basis__	1,941	4,440	W	W	W	W	W	W
Uranium (recoverable content U_3O_8)____thousand pounds__	2,736	16,935	2,727	15,832	2,536	15,725	1,877	11,825
Vanadium (recoverable in ore and concentrate)___short tons__	W	W	W	W	W	W	W	W
Zinc (recoverable content of ores, etc.)____do____	53,715	15,685	56,694	17,370	61,181	19,700	63,801	22,649
Value of items that cannot be disclosed: Cement, fluorspar, iron ore, scrap mica (1970–71), perlite, rare-earth metal concentrates (1969), salt and values indicated by symbol W__	XX	32,745	XX	169,060	XX	147,117	XX	146,843
Total____	XX	368,494	XX	389,824	XX	392,721	XX	425,841
CONNECTICUT								
Clays____thousand short tons__	197	341	171	386	174	322	157	292
Gem stones____	NA	8	NA	8	NA	15	NA	16
Mica, scrap____thousand short tons__	W	W	W	W	3	W	2	W
Sand and gravel____do____	8,857	10,359	6,765	9,202	6,921	10,262	6,763	11,270
Stone____do____	7,562	15,325	8,338	16,915	7,193	15,649	8,719	19,695
Value of items that cannot be disclosed: Feldspar, lime, and values indicated by symbol W____	XX	1,734	XX	1,872	XX	1,713	XX	1,850
Total____	XX	27,767	XX	28,383	XX	27,961	XX	33,123
DELAWARE								
Clays____thousand short tons__	11	11	11	11	14	8	15	9
Gem stones____	NA	1	NA	1	NA	2	NA	W
Sand and gravel____thousand short tons__	2,257	2,074	1,565	1,603	2,205	2,231	2,257	2,660
Value of items that cannot be disclosed: Other nonmetals and values indicated by symbol W____	--	--	--	--	--	--	XX	202
Total____	XX	2,086	XX	1,615	XX	2,241	XX	2,871
FLORIDA								
Cement:								
Masonry____thousand short tons__	W	W	W	W	180	4,877	213	6,901
Portland____do____	W	W	W	W	2,177	48,970	2,425	59,773
Clays____do____	907	13,627	872	12,661	[3] 993	12,834	[3] 922	10,336

See footnotes at end of table.

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

Mineral	1969 Quantity	1969 Value (thousands)	1970 Quantity	1970 Value (thousands)	1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
FLORIDA—Continued								
Lime thousand short tons	182	$2,712	167	$2,810	159	$2,958	180	$3,527
Natural gas million cubic feet	50	8	--	--	903	270	15,521	4,967
Peat thousand short tons	55	359	46	304	57	412	45	362
Petroleum (crude) thousand 42-gallon barrels	1,731	W	2,999	W	5,347	W	16,897	W
Sand and gravel thousand short tons	14,409	13,988	12,482	12,254	23,228	18,836	20,752	15,025
Stone [4] do	42,332	56,611	43,089	61,302	42,816	64,332	53,093	81,621
Value of items that cannot be disclosed: Kaolin (1971–72), kyanite, magnesium compounds, natural gas liquids, phosphate rock, staurolite, stone (dimension limestone 1969–70, shell 1972), titanium concentrate, zircon concentrate and values indicated by symbol W	XX	208,071	XX	210,711	XX	190,242	XX	241,775
Total	XX	295,376	XX	300,042	XX	343,731	XX	424,287
GEORGIA								
Barite thousand short tons	124	3,116	W	W	W	W	W	W
Cement:								
Masonry do	W	W	W	W	63	1,470	68	1,569
Portland do	W	W	W	W	1,214	22,470	1,260	27,286
Clays do	5,670	98,462	5,684	110,149	[3] 5,791	[3] 119,096	[3] 6,227	[3] 132,322
Iron ore (usable) thousand long tons, gross weight	241	1,338	243	1,467	W	W	W	W
Peat thousand short tons	W	W	W	W	1	13	W	W
Sand and gravel do	3,824	4,709	3,667	4,437	3,697	5,310	3,816	4,729
Stone do	27,755	59,451	26,635	59,200	30,669	69,897	37,074	82,484
Talc short tons	47,790	301	45,900	289	53,000	334	45,842	338
Value of items that cannot be disclosed: Bauxite, fire clay (1971–72), feldspar, kyanite, scrap mica, rare-earth metal concentrates, titanium concentrate, zircon concentrate, and values indicated by symbol W	XX	23,525	XX	27,683	XX	r 10,895	XX	9,313
Total	XX	190,902	XX	203,225	XX	r 229,485	XX	258,041
HAWAII								
Cement:								
Masonry thousand short tons	--	--	11	366	11	431	13	384
Portland do	390	10,544	396	9,968	375	10,196	402	10,732
Clays do	2	9	2	11	W	W	W	W
Gem stones	W	W	W	W	NA	54	NA	57
Lime thousand short tons	9	287	9	338	8	228	7	266
Pumice, pumicite, and volcanic ash do	403	783	350	933	289	779	379	762
Sand and gravel do	552	1,816	514	1,679	836	1,967	609	1,893
Stone do	6,534	16,059	[4] 6,332	15,538	[4] 6,056	14,357	[4] 5,005	13,494
Value of items that cannot be disclosed: Salt, and value of items indicated by symbol W	XX	41	XX	132	XX	r 95	XX	486

Total	XX	29,539	XX	28,965	XX	28,107	XX	28,074
IDAHO								
Antimony ore and concentrate..short tons, antimony content	922	W	993	W	857	817	345	303
Clays..thousand short tons	[3] 23	[3] 51	[3] 13	[3] 28	W	W	57	415
Copper (recoverable content of ores, etc.)..short tons	3,332	3,168	3,612	4,168	3,776	3,927	2,942	3,013
Gem stones	NA	90	NA	90	NA	100	NA	105
Gold (recoverable content of ores, etc.)..troy ounces	3,403	141	3,128	114	3,596	148	2,884	169
Lead (recoverable content of ores, etc.)..short tons	65,597	19,541	61,211	19,121	66,610	18,384	61,407	18,459
Mercury..76-pound flasks	1,012	511	1,038	423	1,057	309	161	35
Peat..thousand short tons	1	W	W	W	W	W	--	--
Phosphate rock..do	W	W	W	W	W	W	W	W
Pumice..do	21	62	53	94	W	W	W	W
Sand and gravel..do	8,555	7,583	12,953	10,022	11,279	11,437	7,696	10,294
Silver (recoverable content of ores, etc.)..thousand troy ounces	18,930	33,897	19,115	33,849	19,140	29,590	14,251	24,012
Stone..thousand short tons	3,750	6,426	[4] 4,240	[4] 6,368	4,149	6,118	3,094	7,042
Tungsten concentrate..short tons, 60% WO_3 basis	27	63	W	W	25	66	W	W
Zinc (recoverable content of ores, etc.)..short tons	55,900	16,323	41,052	12,578	45,078	14,515	38,647	13,720
Value of items that cannot be disclosed: Cement, clays, (fire clay and kaolin 1969–71), fluorspar (1971), abrasive garnet, iron ore, lime, perlite, stone (dimension 1970), vanadium and values indicated by symbol W	XX	30,453	XX	32,904	XX	26,869	XX	28,639
Total	XX	118,309	XX	119,759	XX	112,280	XX	106,206
ILLINOIS								
Cement:								
Portland..thousand short tons	1,639	29,996	1,494	25,252	1,425	25,975	1,571	33,124
Masonry..do	84	2,137	71	1,874	73	2,336	80	2,483
Clays [3]..do	1,863	4,321	1,676	3,862	1,788	4,294	1,716	3,314
Coal (bituminous)..do	64,722	279,712	65,119	320,705	58,402	318,878	65,523	402,481
Fluorspar..short tons	88,480	4,676	148,208	8,637	138,051	9,883	132,405	9,961
Gem stones	NA	W	NA	W	NA	2	NA	2
Lead (recoverable content of ores, etc.)..short tons	791	236	1,532	479	1,238	342	1,335	401
Natural gas..million cubic feet	3,800	536	4,850	761	498	[r] 139	1,194	334
Peat..thousand short tons	67	958	63	711	72	W	74	935
Petroleum (crude)..thousand 42-gallon barrels	50,724	161,302	43,747	141,994	39,084	135,621	34,874	121,013
Sand and gravel..thousand short tons	44,138	56,688	43,926	60,155	45,364	59,397	39,929	61,696
Stone..do	54,857	81,318	55,776	86,502	[4] 61,991	[4] 106,084	[4] 56,260	[4] 94,225
Zinc (recoverable content of ores, etc.)..short tons	13,765	4,019	16,797	5,146	12,706	4,091	11,378	4,039
Value of items that cannot be disclosed: Clay (fuller's earth), lime, natural gas liquids, silver (1971–72), tripoli and values indicated by symbol W	XX	33,916	XX	32,619	XX	33,830	XX	35,729
Total	XX	659,815	XX	688,697	XX	[r] 700,870	XX	769,737
INDIANA								
Abrasive stones..short tons	5	17	W	W	W	W	W	W
Cement..thousand short tons	[2] 2,725	[2] 45,264	[2] 2,151	[2] 41,810	W	W	W	W
Clays..do	1,483	2,264	1,335	2,139	[3] 1,324	[r] 2,308	1,419	2,465
Coal (bituminous)..do	20,086	82,902	22,263	102,371	21,396	110,796	25,949	144,688

See footnotes at end of table.

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

Mineral	1969 Quantity	1969 Value (thousands)	1970 Quantity	1970 Value (thousands)	1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
INDIANA—Continued								
Natural gas ... million cubic feet	171	$40	153	$36	537	r $89	355	$55
Peat ... thousand short tons	38	515	W	W	50	W	45	478
Petroleum (crude) ... thousand 42-gallon barrels	7,841	25,013	7,487	23,958	6,658	22,770	6,130	20,964
Sand and gravel ... thousand short tons	26,218	27,438	23,476	25,796	24,982	29,094	27,978	33,290
Stone ... do	25,559	45,400	25,818	45,215	26,233	48,218	27,511	50,919
Value of items that cannot be disclosed: Cement (masonry, 1969–70), gypsum, lime, and values indicated by symbol W	XX	13,018	XX	14,461	XX	r 68,246	XX	69,749
Total	XX	241,871	XX	255,786	XX	r 281,521	XX	322,608
IOWA								
Cement:								
Portland ... thousand short tons	2,648	47,265	2,396	45,432	2,392	47,925	2,458	49,635
Masonry ... do	85	1,912	73	1,758	66	1,719	66	1,916
Clays ... do	1,199	1,660	1,181	1,823	[3] 1,028	[3] 1,702	1,047	2,643
Coal (bituminous) ... do	903	3,392	987	4,059	989	4,609	851	4,138
Gem stones	W	W	W	W	W	W	NA	1
Gypsum ... thousand short tons	1,169	5,274	1,136	4,223	1,154	4,460	1,380	5,714
Sand and gravel ... do	18,391	17,867	21,058	20,642	18,279	20,530	17,107	20,140
Stone ... do	26,233	40,895	25,305	41,119	[4] 25,389	[4] 44,977	27,457	48,642
Value of items that cannot be disclosed: Clay (fire, 1971), lime, peat, and dimension stone (1971)	XX	1,665	XX	1,766	XX	1,899	XX	1,667
Total	XX	119,930	XX	120,822	XX	127,821	XX	134,496
KANSAS								
Cement:								
Portland ... thousand short tons	1,836	29,365	1,729	28,177	1,731	29,961	1,889	35,432
Masonry ... do	49	1,023	46	1,029	50	1,232	59	1,452
Clays ... do	[3] 797	[3] 1,070	[3] 713	[3] 946	879	1,151	1,170	1,457
Coal (bituminous) ... do	1,313	7,108	1,627	9,102	1,151	6,579	1,227	7,835
Helium:								
Crude ... million cubic feet	2,669	32,667	2,250	30,600	2,510	30,120	2,273	27,276
High purity ... do	330	7,578	354	8,137	342	7,182	384	8,064
Lead (recoverable content of ores, etc.) ... short tons	395	118	80	25	--	--	--	--
Lime ... thousand short tons	7	W	6	W	8	W	9	172
Natural gas ... million cubic feet	883,156	122,759	899,955	125,994	885,144	127,267	889,268	127,859
Natural gas liquids:								
Natural gasoline ... thousand 42-gallon barrels	4,855	11,848	6,549	14,617	5,387	12,253	5,505	13,170
LPG ... do	19,574	26,229	20,814	30,597	23,215	39,001	25,099	43,170
Petroleum (crude) ... do	88,716	283,891	84,853	277,469	78,532	276,433	73,744	259,578
Pumice ... thousand short tons	W	W	W	W	W	W	W	W
Salt [6] ... do	1,270	17,090	1,230	18,206	1,240	18,712	1,369	20,562
Sand and gravel ... do	12,029	10,061	12,968	12,351	11,862	11,351	11,591	10,920

Stone ....do	15,828	22,645	15,161	22,406	[4] 14,908	23,697	[4] 14,547	[4] 23,849
Zinc (recoverable content of ores, etc.) ....short tons	1,900	555	1,186	364	--	--	--	--
Value of items that cannot be disclosed: Natural cement (1969), clays (1969–70), gypsum, salt (brine), and values indicated by symbol W	XX	3,808	XX	3,969	XX	4,505	XX	3,741
Total	XX	577,815	XX	583,989	XX	589,444	XX	584,537
KENTUCKY								
Clays [3] ....thousand short tons	1,232	2,076	1,020	1,793	956	1,377	920	1,406
Coal (bituminous) ....do	109,049	450,950	125,305	711,163	119,389	774,735	121,188	824,691
Natural gas ....million cubic feet	81,304	20,407	77,892	19,161	72,723	18,253	63,648	15,976
Petroleum (crude) ....thousand 42-gallon barrels	12,924	40,194	11,575	36,461	10,692	35,925	9,702	32,599
Sand and gravel ....thousand short tons	8,364	9,628	8,760	10,474	8,202	11,061	8,485	11,967
Stone [4] ....do	30,158	44,644	29,310	45,208	32,514	52,296	34,279	59,690
Zinc (recoverable content of ores, etc.) ....short tons	W	W	4,189	1,283	5,268	1,696	1,780	632
Value of items that cannot be disclosed: Cement, ball clay, fluorspar, lime (1971–72), natural gas liquids, stone, and values indicated by symbol W	XX	23,148	XX	21,922	XX	30,542	XX	29,949
Total	XX	591,047	XX	847,465	XX	925,885	XX	976,910
LOUISIANA								
Clays ....thousand short tons	1,078	2,943	1,080	1,575	1,073	1,606	1,000	1,454
Lime ....do	822	10,750	1,025	12,811	960	17,625	908	19,614
Natural gas ....million cubic feet	7,227,826	1,387,743	7,788,276	1,503,137	8,081,907	1,632,545	7,972,678	1,626,426
Natural gas liquids:								
Natural gasoline and cycle products thousand 42-gallon barrels	53,565	171,434	56,526	174,632	54,424	173,425	52,842	167,768
LPG ....do	71,867	96,302	80,385	138,262	90,271	166,099	98,233	185,660
Petroleum (crude) ....do	844,603	2,791,269	906,907	3,061,558	935,243	3,359,710	891,827	3,201,659
Salt ....thousand short tons	12,435	61,102	13,584	64,854	13,352	67,950	13,514	67,464
Sand and gravel ....do	18,131	21,895	18,155	22,363	19,228	24,492	18,920	26,996
Stone [4] ....do	9,237	11,892	9,183	11,945	9,688	14,139	9,190	14,836
Sulfur (Frasch process) ....thousand long tons	3,999	108,299	3,618	89,489	r3,646	W	3,765	W
Value of items that cannot be disclosed: Cement, gypsum, miscellaneous stone, and values indicated by symbol W	XX	21,697	XX	21,695	XX	r94,739	XX	99,666
Total	XX	4,685,326	XX	5,102,321	XX	r5,552,330	XX	5,411,543
MAINE								
Clays [3] ....thousand short tons	42	56	41	55	42	56	40	57
Copper ....short tons	W	W	2,703	3,120	2,510	2,610	1,220	1,249
Gem stones	NA	35	NA	35	NA	40	NA	W
Lead ....short tons	--	--	--	--	--	--	85	26
Peat ....thousand short tons	W	W	W	W	2	W	2	99
Sand and gravel ....do	11,275	6,026	12,971	6,888	8,292	5,881	11,818	7,585
Silver ....thousand troy ounces	W	W	63	112	41	64	16	27
Stone ....thousand short tons	1,101	3,798	W	W	1,133	2,913	1,078	2,996
Zinc (recoverable contents of ores, etc.) ....short tons	W	W	9,114	2,792	5,850	1,884	5,820	2,066

See footnotes at end of table.

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

Mineral	1969 Quantity	1969 Value (thousands)	1970 Quantity	1970 Value (thousands)	1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
MAINE—Continued								
Value of items that cannot be disclosed: Beryllium (1969–70), cement, clays, feldspar (1969–70), and values indicated by symbol W	XX	$10,273	XX	$10,778	XX	$8,450	XX	$8,867
Total	XX	20,188	XX	23,780	XX	21,898	XX	22,922
MARYLAND								
Clays [3] thousand short tons	1,152	1,369	1,129	1,433	1,027	1,558	1,104	2,121
Coal (bituminous) do	1,368	5,261	1,615	8,083	1,644	10,274	1,640	8,961
Gem stones	NA	3	NA	3	NA	8	NA	8
Natural gas million cubic feet	978	248	813	202	214	r 43	244	51
Peat thousand short tons	4	78	4	47	3	39	3	29
Sand and gravel do	14,230	21,226	12,951	20,434	12,842	23,201	12,594	26,557
Stone do	15,067	30,504	16,015	32,783	15,912	34,770	19,431	41,973
Value of items that cannot be disclosed: Cement, selected clays, diatomite (1969), lime, greensand marl, potassium salts (1968–70), and talc and soapstone	XX	24,794	XX	25,231	XX	29,527	XX	35,801
Total	XX	83,483	XX	88,216	XX	r 99,420	XX	115,501
MASSACHUSETTS								
Clays thousand short tons	332	624	284	582	186	377	219	416
Gem stones	NA	2	NA	2	NA	r 5	NA	5
Lime thousand short tons	199	3,718	W	W	W	W	W	W
Peat do	W	W	W	W	2	32	W	W
Sand and gravel do	19,456	22,950	17,925	22,244	17,343	23,058	18,883	25,655
Stone do	7,847	22,521	8,136	24,349	7,816	23,582	7,990	23,500
Value of items that cannot be disclosed: Nonmetals and values indicated by symbol W	XX	28	XX	3,183	XX	r 3,145	XX	2,852
Total	XX	49,843	XX	50,360	XX	50,199	XX	52,428
MICHIGAN								
Cement:								
Portland thousand short tons	5,710	98,425	5,605	101,019	6,108	104,665	5,901	111,410
Masonry do	266	5,473	213	5,253	239	5,872	250	5,959
Clays do	2,667	3,037	2,480	2,887	2,458	3,366	2,514	3,715
Copper (recoverable content of ores, etc.) short tons	75,226	71,516	67,543	77,945	56,005	58,245	67,260	68,874
Gem stones	NA	W	NA	W	NA	8	NA	8
Gypsum thousand short tons	1,327	5,384	1,312	5,061	1,433	5,585	1,650	7,267
Iron ore (usable) thousand long tons, gross weight	14,058	169,756	13,100	168,958	11,833	159,854	12,692	177,461
Lime thousand short tons	1,589	20,372	1,538	21,355	1,444	20,549	1,509	22,753
Magnesium compounds from sea water and brine (except for								

metal) short tons, MgO equivalent	321,191	30,343	411,911	38,050	272,918	27,777	377,675	31,484
Natural gas million cubic feet	36,163	9,294	38,851	10,373	25,662	6,776	34,221	10,506
Natural gas liquids:								
Natural gasoline thousand 42-gallon barrels	921	2,481	599	1,611	553	1,513	395	1,097
LPG do	1,197	2,561	1,176	2,764	975	2,623	833	2,274
Peat thousand short tons	186	2,724	167	1,896	202	2,497	219	2,190
Petroleum (crude) thousand 42-gallon barrels	12,213	37,494	11,693	36,246	11,893	38,859	12,990	41,556
Salt thousand short tons	4,819	45,961	4,899	49,963	4,458	49,007	4,358	50,761
Sand and gravel do	58,092	58,968	53,092	54,646	56,613	62,898	59,467	65,445
Silver (recoverable content of ores, etc.) thousand troy ounces	1,009	1,807	892	1,579	670	1,036	785	1,323
Stone thousand short tons	39,186	43,572	41,687	49,501	40,705	49,240	39,754	50,317
Value of items that cannot be disclosed: Bromine, calcium-magnesium chloride, iodine, and potassium salts (1969–70)	XX	58,818	XX	41,622	XX	r 40,266	XX	40,367
Total	XX	667,986	XX	670,729	XX	640,636	XX	694,767
MINNESOTA								
Clays thousand short tons	[3] 275	[3] 412	227	335	223	335	[3] 167	[3] 251
Gem stones	W	W	W	W	NA	13	NA	14
Iron ore (usable) thousand long tons, gross weight	56,957	570,446	54,791	571,488	49,054	547,607	50,595	601,869
Manganiferous ore (5% to 35% Mn) short tons, gross weight	381,491	W	321,436	W	169,732	W	119,324	W
Peat thousand short tons	12	249	14	335	W	W	W	W
Sand and gravel do	48,121	40,191	46,851	38,802	44,916	37,645	36,792	33,454
Stone do	5,035	14,253	4,579	12,311	5,838	14,346	5,757	16,318
Value of items that cannot be disclosed: Abrasive stones, cement, clays (selected, 1969, 1972), lime, and values indicated by symbol W	XX	10,085	XX	9,735	XX	r 8,830	XX	7,763
Total	XX	635,636	XX	683,006	XX	608,776	XX	659,669
MISSISSIPPI								
Clays thousand short tons	1,703	8,660	1,553	8,062	2,278	8,501	1,919	7,837
Natural gas million cubic feet	131,234	23,097	126,031	23,190	118,805	24,830	103,989	28,077
Natural gas liquids:								
Natural gasoline and cycle products thousand 42-gallon barrels	565	1,572	544	1,465	W	W	W	W
LPG do	538	799	428	964	W	W	W	W
Petroleum (crude) do	64,283	187,514	65,119	194,706	64,066	201,808	61,100	192,465
Sand and gravel thousand short tons	11,484	12,263	10,859	11,950	11,289	13,526	13,419	16,133
Stone do	W	W	W	W	r 726	r 709	1,135	1,199
Value of items that cannot be disclosed: Cement, lime, magnesium compounds, and values indicated by symbol W	XX	9,279	XX	9,636	XX	12,790	XX	14,970
Total	XX	243,184	XX	249,973	XX	r 262,164	XX	260,681
MISSOURI								
Barite thousand short tons	304	4,220	230	3,555	232	3,606	213	3,637
Cement:								
Portland do	4,009	74,368	3,990	64,261	4,515	77,568	4,277	80,898
Masonry do	60	1,319	56	1,234	73	1,629	80	1,859
Clays [3] do	2,251	6,405	2,128	6,480	2,354	7,454	2,571	9,096
Coal (bituminous) do	3,301	14,283	4,447	19,526	4,036	19,670	4,551	23,667

See footnotes at end of table.

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

Mineral	1969 Quantity	1969 Value (thousands)	1970 Quantity	1970 Value (thousands)	1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
MISSOURI—Continued								
Copper (recoverable content of ores, etc.) short tons	12,664	$12,039	12,134	$14,003	8,445	$8,783	11,509	$11,785
Iron ore (usable) thousand long tons, gross weight	2,622	35,826	2,612	38,100	2,727	W	2,695	W
Lead (recoverable content of ores, etc.) short tons	355,452	105,889	421,764	131,751	429,634	118,579	489,397	147,113
Natural gas million cubic feet	126	17	87	21	22	5	9	2
Petroleum (crude) thousand 42-gallon barrels	67	W	66	W	66	W	60	W
Sand and gravel thousand short tons	10,940	14,574	12,446	15,379	10,327	15,109	10,082	14,806
Silver (recoverable content of ores, etc.) thousand troy ounces	1,442	2,582	1,817	3,218	1,661	2,568	1,972	3,322
Stone thousand short tons	41,977	63,251	39,726	[4] 57,285	41,099	[4] 64,772	42,473	[4] 63,219
Zinc (recoverable content of ores, etc.) short tons	41,099	12,001	50,721	15,540	48,215	15,525	61,923	21,983
Value of items that cannot be disclosed: Native asphalt, lime, and values indicated by symbol W	XX	20,458	XX	22,643	XX	64,821	XX	70,430
Total	XX	367,232	XX	392,996	XX	400,089	XX	451,817
MONTANA								
Antimony short tons	--	--	W	W	135	81	W	W
Clays [3] thousand short tons	34	63	41	71	264	1,712	304	1,590
Coal (bituminous and lignite) do	1,030	2,199	3,447	6,394	7,064	12,817	8,221	16,690
Copper (recoverable content of ores, etc.) short tons	103,314	98,219	120,412	138,955	88,581	92,125	123,110	126,064
Gem stones	NA	109	NA	109	NA	114	NA	120
Gold (recoverable content of ores, etc.) troy ounces	24,189	1,004	22,456	817	15,613	644	23,725	1,390
Iron ore (usable) thousand long tons, gross weight	13	W	14	W	14	W	9	W
Lead (recoverable content of ores, etc.) short tons	1,753	522	996	311	615	169	287	86
Lime thousand short tons	255	2,737	208	W	199	2,416	242	3,003
Manganese ore and concentrate (35% or more Mn) short tons, gross weight	775	26	512	W	142	W	578	W
Natural gas million cubic feet	41,229	4,205	42,705	4,399	32,720	3,959	33,474	4,117
Petroleum (crude) thousand 42-gallon barrels	43,954	118,359	37,879	105,403	34,599	104,128	33,904	103,924
Pumice thousand short tons	134	102	--	--	--	--	--	--
Sand and gravel do	16,595	14,383	19,275	20,249	15,781	25,207	10,116	17,149
Silver (recoverable content of ores, etc.) thousand troy ounces	3,429	6,141	4,304	7,622	2,748	4,248	3,325	5,603
Stone thousand short tons	7,667	10,579	[4] 6,501	[4] 6,896	W	W	4,074	5,627
Tungsten ore and concentrate short tons, 60% WO_3 basis	W	W	9	23	W	W	W	W
Zinc (recoverable content of ores, etc.) short tons	6,143	1,794	1,457	446	361	116	12	4
Value of items that cannot be disclosed: Cement, clays (selected), fluorspar, gypsum, natural gas liquids, peat, phosphate rock, stone (1970–71), talc, vermiculite, and values indicated by symbol W	XX	22,189	XX	21,321	XX	37,337	XX	22,309
Total	XX	282,631	XX	313,016	XX	285,073	XX	307,676
NEBRASKA								
Clays thousand short tons	149	223	90	147	69	82	115	143

Gem stones	NA	5	NA	5	NA	10	NA	11
Lime thousand short tons	35	W	27	W	29	W	34	685
Natural gas (marketed) million cubic feet	6,989	1,209	5,991	1,024	3,496	612	3,478	619
Natural gas liquids:								
Natural gasoline thousand 42-gallon barrels	128	387	W	W	W	W	W	W
LPG do	408	738	365	858	W	W	W	W
Petroleum (crude) do	12,106	36,075	11,451	35,384	10,062	34,010	8,705	29,423
Sand and gravel thousand short tons	12,758	13,592	12,232	12,974	13,224	13,626	13,720	15,063
Stone do	4,665	9,494	4,265	7,378	4,174	7,892	4,251	7,645
Value of items that cannot be disclosed: Cement, pumice, and values indicated by symbol W	XX	16,307	XX	14,887	XX	17,847	XX	20,086
Total	XX	78,030	XX	72,657	XX	74,079	XX	73,675
NEVADA								
Antimony ore and concentrate short tons, antimony content	W	W	W	W	W	W	W	W
Barite thousand short tons	320	2,275	192	1,455	192	1,490	317	2,659
Clays do	W	W	W	W	W	W	40	183
Copper (recoverable content of ores, etc.) short tons	104,924	99,749	106,688	123,118	96,928	100,806	101,119	103,545
Gem stones	NA	100	NA	100	NA	105	NA	110
Gold (recoverable content of ores, etc.) troy ounces	456,294	18,941	480,144	17,472	374,878	15,464	419,748	24,597
Gypsum thousand short tons	521	1,550	451	1,457	695	2,372	860	2,871
Iron ore (usable) thousand long tons, gross weight	W	W	575	W	W	W	W	W
Lead (recoverable content of ores, etc.) short tons	1,420	423	364	114	111	30	(5)	(5)
Mercury 76-pound flasks	8,165	4,124	4,909	2,001	1,589	465	810	177
Perlite short tons	8,998	77	8,470	73	9,600	114	W	W
Petroleum (crude) thousand 42-gallon barrels	223	W	149	W	113	W	100	W
Pumice thousand short tons	83	188	80	191	112	232	W	W
Sand and gravel do	8,447	10,834	8,574	9,819	9,379	12,225	10,081	12,636
Silver (recoverable content of ores, etc.) thousand troy ounces	884	1,583	718	1,271	601	930	595	1,003
Stone thousand short tons	1,494	2,433	1,860	2,722	2,531	3,800	3,329	5,926
Talc and soapstone short tons	6,434	81	W	W	--	--	W	W
Tungsten ore and concentrate short tons, 60% WO_3 basis	34	69	122	306	33	88	165	W
Zinc (recoverable content of ores, etc.) short tons	941	275	127	39	71	23	--	--
Value of items that cannot be disclosed: Brucite, cement, diatomite, fluorspar, lime, lithium minerals, magnesite, molybdenum, pyrites, salt, and values indicated by symbol W	XX	r 25,594	XX	r 26,207	XX	r 26,630	XX	27,995
Total	XX	168,296	XX	186,345	XX	164,774	XX	181,702
NEW HAMPSHIRE								
Clays thousand short tons	44	40	40	32	37	34	51	70
Gem stones	W	W	W	W	NA	40	NA	42
Sand and gravel thousand short tons	6,310	5,149	6,529	4,753	8,404	6,777	6,020	6,256
Stone do	320	2,888	W	845	429	3,433	528	3,743
Value of items that cannot be disclosed: Feldspar (1969), mica scrap (1969–70), and values indicated by symbol W	XX	43	XX	3,100	--	--	--	--
Total	XX	8,120	XX	8,730	XX	10,284	XX	10,111

See footnotes at end of table.

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

Mineral	1969 Quantity	1969 Value (thousands)	1970 Quantity	1970 Value (thousands)	1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
NEW JERSEY								
Clays ... thousand short tons	327	$1,123	262	$990	201	$864	212	$856
Gem stones	NA	10	NA	10	NA	15	NA	16
Peat ... thousand short tons	46	551	45	557	46	526	W	W
Sand and gravel ... do	20,325	33,977	16,732	31,571	18,511	38,279	17,679	38,020
Stone ... do	15,162	34,034	[4] 15,160	[4] 40,567	[4] 13,469	[4] 36,057	[4] 18,651	[4] 53,083
Zinc (recoverable content of ores, etc.) ... short tons	25,076	7,322	28,683	8,788	29,977	9,653	38,096	13,524
Value of items that cannot be disclosed: Lime, magnesium compounds, manganiferous residuum, greensand marl, stone dimension, 1970–72), and titanium concentrate	XX	6,122	XX	6,798	XX	r 8,178	XX	8,261
Total	XX	83,139	XX	89,281	XX	r 93,572	XX	118,760
NEW MEXICO								
Carbon dioxide, natural ... thousand cubic feet	902,186	69	W	W	W	W	W	W
Clays ... thousand short tons	70	89	67	91	[3] 76	[3] 114	[3] 65	108
Coal (bituminous) ... do	4,471	16,376	7,361	21,249	8,175	26,657	8,248	29,794
Copper (recoverable content of ores, etc.) ... short tons	119,956	114,040	166,278	191,885	157,419	163,716	168,034	172,067
Feldspar ... long tons	W	W	--	--	--	--	--	
Gem stones	NA	60	NA	60	NA	65	NA	68
Gold (recoverable content of ores, etc.) ... troy ounces	8,952	372	8,719	317	10,681	441	14,897	873
Gypsum ... thousand short tons	141	526	W	W	W	W	W	W
Helium:								
Crude ... million cubic feet	--	--	1	18	--	--		
High-purity ... do	13	260	(5)	6	W	W	--	--
Iron ore (usable) ... thousand long tons, gross weight	W	W	W	W	W	W	W	W
Lead (recoverable content of ores, etc.) ... short tons	2,368	705	3,550	1,109	2,971	820	3,582	1,077
Lime ... thousand short tons	37	W	37	W	35	W	28	W
Manganese ore (5% to 35% Mn) ... short tons, gross weight	4,855	131	4,225	W	--	--	--	--
Manganiferous ore (5% to 35% Mn) ... do	49,146	340	46,166	W	28,490	W	27,837	W
Natural gas ... million cubic feet	1,138,133	155,924	1,138,980	162,874	1,167,577	175,137	1,216,061	225,420
Natural gas liquids:								
Natural gasoline and cycle products ... thousand 42-gallon barrels	9,053	24,388	9,606	25,548	9,952	28,465	10,338	29,970
LPG ... do	24,920	30,402	25,999	37,179	27,082	43,331	27,859	45,689
Peat ... thousand short tons	(5)	4	(5)	7	1	W	2	46
Perlite ... do	398	4,493	382	4,321	386	4,559	476	5,698
Petroleum (crude) ... thousand 42-gallon barrels	129,227	404,441	128,184	410,320	118,412	402,602	110,525	376,778
Potassium salts ... thousand short tons, K_2O equivalent	2,327	62,034	2,390	85,877	2,291	86,689	2,296	91,115
Pumice ... thousand short tons	226	415	203	442	287	601	311	809
Salt ... do	W	W	W	W	146	1,130	W	W
Sand and gravel ... do	8,574	10,422	10,666	10,516	8,869	7,975	7,600	8,553
Silver (recoverable content of ores, etc.) ... thousand troy ounces	466	834	782	1,385	782	1,210	1,017	1,713
Stone ... thousand short tons	2,826	3,286	[4] 3,110	[4] 4,030	[4] 2,913	[4] 5,337	2,768	5,499
Uranium (recoverable content U_3O_8) ... thousand pounds	11,811	69,887	11,574	69,970	10,567	65,517	10,808	68,091
Zinc (recoverable content of ores, etc.) ... short tons	24,308	7,098	16,601	5,086	13,959	4,495	12,735	4,521

Value of items that cannot be disclosed: Beryllium (1969), cement, fluorspar, mica scrap, molybdenum, stone (1970–71), tin (1969), vanadium and values indicated by symbol W	XX	29,150	XX	28,068	XX	27,424	XX	29,403
Total	XX	935,746	XX	1,060,358	XX	1,046,285	XX	1,097,292
NEW YORK								
Clays ..... thousand short tons	1,623	1,783	1,707	1,897	[3] 1,588	[3] 1,742	[3] 1,601	[3] 1,919
Emery ..... short tons	W	W	W	W	1,585	W	2,883	W
Gem stones	NA	10	NA	10	NA	15	NA	16
Gypsum ..... thousand short tons	492	2,945	425	2,737	415	2,376	486	3,079
Lead (recoverable content of ores, etc.) ..... short tons	1,686	502	1,280	400	877	242	1,089	327
Lime ..... thousand short tons	1,055	10,224	W	W	W	W	W	W
Mercury ..... 76-pound flasks	280	141	28	11	W	W	W	W
Natural gas ..... million cubic feet	4,861	1,458	3,358	1,017	2,202	661	3,679	1,199
Peat ..... thousand short tons	14	178	15	145	15	196	15	200
Petroleum (crude) ..... thousand 42-gallon barrels	1,256	5,683	1,194	5,397	1,126	5,292	1,018	4,897
Salt ..... thousand short tons	5,582	45,561	5,990	47,254	5,303	43,601	5,604	43,866
Sand and gravel ..... do	39,806	42,518	35,537	38,839	23,221	28,328	26,722	36,952
Silver (recoverable content of ores, etc.) ..... thousand troy ounces	32	57	24	42	18	28	25	42
Stone ..... thousand short tons	37,561	66,839	37,616	68,118	37,778	73,418	38,138	77,825
Zinc (recoverable content of ores, etc.) ..... short tons	58,728	17,149	58,577	17,947	63,420	20,421	60,749	21,566
Value of items that cannot be disclosed: Cement, clays (ball, 1971–72), abrasive garnet, iron ore, talc, titanium concentrate, wollastonite, and values indicated by symbol W	XX	107,432	XX	115,750	XX	r 122,963	XX	128,565
Total	XX	302,480	XX	299,564	XX	r 299,283	XX	320,453
NORTH CAROLINA								
Clays [3] ..... thousand short tons	3,342	2,610	3,318	3,102	3,503	3,802	3,862	4,473
Feldspar ..... short tons	r 378,727	4,615	r 386,608	5,173	r 393,811	4,681	439,838	6,030
Gem stones	NA	20	NA	20	NA	30	NA	32
Mica:								
Scrap ..... thousand short tons	67	1,513	64	1,457	67	1,770	91	2,942
Sheet ..... pounds	W	3	--	--	8,705	3		--
Sand and gravel ..... thousand short tons	10,562	11,437	12,772	13,277	14,240	14,690	13,485	14,615
Stone ..... do	26,812	47,829	30,363	54,121	30,917	58,026	32,297	62,741
Talc and pyrophyllite ..... short tons	105,728	586	92,639	544	85,289	522	89,334	594
Value of items that cannot be disclosed: Asbestos, cement, clay (kaolin), copper (1971), gold (1971), iron ore, lead (1971), lithium minerals, olivine, phosphate rock, silver (1971), tungsten (1970–71), and zinc (1971)	XX	21,843	XX	20,671	XX	r 25,996	XX	24,896
Total	XX	90,456	XX	98,365	XX	r 109,520	XX	116,323
NORTH DAKOTA								
Coal (lignite) ..... thousand short tons	4,704	8,696	5,639	11,009	6,075	11,580	6,632	13,416
Gem stones	NA	1	NA	1	NA	2	NA	2
Natural gas ..... million cubic feet	33,587	5,441	34,889	5,722	33,864	5,655	32,472	5,455
Natural gas liquids:								
Natural gasoline ..... thousand 42-gallon barrels	508	1,346	504	1,376	W	W	W	W
LPG ..... do	1,951	2,868	1,840	2,944	W	W	W	W

See footnotes at end of table.

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

Mineral	1969 Quantity	1969 Value (thousands)	1970 Quantity	1970 Value (thousands)	1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
NORTH DAKOTA—Continued								
Petroleum (crude) thousand 42-gallon barrels	22,703	$63,568	21,998	$67,107	21,653	$70,805	20,624	$67,647
Sand and gravel thousand short tons	7,039	7,274	8,090	6,336	8,196	6,210	6,681	5,757
Stone do	72	99	103	126	W	W	--	--
Value of items that cannot be disclosed: Clays, lime, peat (1970–71), pumice (1972), salt, and values indicated by symbol W	XX	1,755	XX	1,426	XX	5,649	XX	5,809
Total	XX	91,048	XX	96,047	XX	99,901	XX	98,086
OHIO								
Cement:								
Portland thousand short tons	2,839	50,071	2,209	39,997	2,897	54,338	2,968	57,953
Masonry do	157	3,527	121	3,116	142	3,811	161	4,684
Clays do	4,587	11,693	3,920	10,100	3,973	11,380	4,125	11,273
Coal (bituminous) do	51,242	210,082	55,351	262,390	51,431	269,601	50,967	303,819
Gem stones	NA	3	NA	3	NA	8	NA	8
Lime thousand short tons	4,159	60,975	3,951	61,197	4,007	65,258	4,413	75,569
Natural gas million cubic feet	49,793	12,837	52,113	14,123	79,903	27,007	89,995	35,271
Peat thousand short tons	11	116	6	95	6	84	4	67
Petroleum (crude) thousand 42-gallon barrels	10,972	36,098	9,864	32,914	8,286	29,801	9,358	35,179
Salt thousand short tons	5,844	43,519	5,329	47,498	5,709	46,651	6,147	47,710
Sand and gravel do	50,029	64,552	42,069	57,506	40,797	54,044	43,506	59,932
Stone do	51,792	86,570	47,244	81,506	46,891	88,372	48,498	90,821
Value of items that cannot be disclosed: Abrasive stone, and gypsum	XX	1,815	XX	1,721	XX	1,796	XX	2,462
Total	XX	581,858	XX	612,166	XX	652,151	XX	724,748
OKLAHOMA								
Clays [3] thousand short tons	802	1,182	769	1,120	845	1,255	938	1,398
Coal (bituminous) do	1,838	10,662	2,427	15,211	2,234	15,004	2,624	19,112
Gypsum do	980	3,912	874	2,616	1,022	3,073	1,196	3,888
Helium:								
High-purity million cubic feet	221	7,717	149	5,214	123	4,305	174	6,090
Crude do	133	1,123	245	2,940	270	3,240	163	1,956
Lead (recoverable content of ores, etc.) short tons	605	180	797	249	--	--	--	--
Natural gas million cubic feet	1,523,715	233,128	1,594,943	248,811	1,684,260	273,945	1,806,887	294,523
Natural gas liquids:								
Natural gasoline and cycle products thousand 42-gallon barrels	14,621	38,931	14,813	39,933	14,197	40,856	14,559	42,709
LPG do	27,304	34,403	28,029	52,975	27,540	56,732	27,148	57,011
Petroleum (crude) do	224,729	701,155	223,574	712,419	213,313	725,611	207,633	709,033
Salt thousand short tons	9	51	13	78	W	W	W	W
Sand and gravel do	5,262	7,156	5,675	7,258	5,713	8,259	7,901	11,138
Stone do	18,799	23,650	18,177	23,701	19,449	27,125	19,448	26,574

Zinc (recoverable content of ores, etc.) short tons	2,744	801	2,650	812	W	W	W	W
Value of items that cannot be disclosed: Cement, clay (bentonite), copper, lime, silver, tripoli, and values indicated by symbol W	XX	26,758	XX	24,935	XX	30,111	XX	37,296
Total	XX	1,090,809	XX	1,138,272	XX	1,189,516	XX	1,210,728
OREGON								
Clays thousand short tons	[3]215	[3]321	[3]134	[3]180	157	255	151	238
Copper short tons	W	W	W	W	3	3	W	W
Diatomite do	85	W	500	5	70	1	W	W
Gem stones	NA	750	NA	750	NA	755	NA	793
Gold (recoverable content of ores, etc.) troy ounces	875	36	256	9	244	10	W	W
Lead short tons	(5)	(5)	(5)	(5)	--	--	--	--
Lime thousand short tons	115	2,337	96	1,777	106	1,989	96	2,129
Mercury 76-pound flasks	43	22	274	112	W	W	--	--
Nickel (content of ore and concentrate) short tons	17,056	W	15,933	W	17,036	W	16,864	W
Pumice thousand short tons	875	1,139	939	1,221	[r]943	[r]1,389	W	W
Sand and gravel do	15,470	20,491	17,532	25,978	20,230	28,707	24,489	34,981
Silver (recoverable content of ores, etc.) thousand troy ounces	5	9	4	6	4	6	2	4
Stone thousand short tons	11,662	18,897	13,439	20,948	13,794	26,708	10,915	18,380
Talc and soapstone short tons	W	W	W	W	W	W	W	W
Value of items that cannot be disclosed: Bauxite (1970), cement, clay (fire clay 1969–70), copper (1969–70), tungsten (1971–72), and values indicated by symbol W	XX	16,162	XX	17,095	XX	18,212	XX	19,991
Total	XX	60,164	XX	68,081	XX	[r]78,035	XX	76,516
PENNSYLVANIA								
Cement:								
Portland thousand short tons	8,440	126,941	7,691	121,100	7,850	140,460	8,214	156,008
Masonry do	432	8,504	527	8,324	559	11,247	451	12,401
Clays do	[3]2,727	[3]19,637	[3]2,665	[3]15,845	[3]2,325	[3]8,940	2,682	15,829
Coal:								
Anthracite do	10,473	100,770	9,729	105,341	8,727	103,469	7,106	85,251
Bituminous do	78,631	461,579	80,491	585,057	73,835	620,196	75,939	694,267
Copper (recoverable content of ores, etc.) short tons	3,382	3,215	2,539	2,930	3,349	3,483	2,611	2,673
Gem stones	NA	4	NA	4	NA	9	NA	9
Lime thousand short tons	2,008	28,952	1,887	29,279	1,760	30,008	1,891	33,802
Mica, scrap do	W	W	1	60	W	W	W	W
Natural gas million cubic feet	79,134	21,841	76,841	21,439	76,451	20,770	73,958	22,389
Natural gas liquids:								
Natural gasoline thousand 42-gallon barrels	22	61	19	50	W	W	W	W
LPG do	35	78	34	87	W	W	W	W
Peat thousand short tons	35	407	44	517	38	461	22	320
Petroleum (crude) thousand 42-gallon barrels	4,448	20,086	4,093	18,500	3,798	17,699	3,441	16,414
Sand and gravel thousand short tons	18,105	31,451	18,504	33,915	19,668	36,162	18,757	36,804
Stone do	66,992	117,726	66,119	120,187	64,467	118,469	67,307	124,840
Zinc (recoverable content of ores, etc.) short tons	33,035	9,646	29,554	9,055	27,438	8,835	18,344	6,512

See footnotes at end of table.

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

Mineral	1969 Quantity	1969 Value (thousands)	1970 Quantity	1970 Value (thousands)	1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
PENNSYLVANIA—Continued								
Value of items that cannot be disclosed: Clay (kaolin 1969–71), cobalt (1969–71), gold (1969–71), iron ore, pyrites (1969–71), pyrophyllite (1969–70), silver (1969–71), tripoli, and values indicated by symbol W	XX	$25,470	XX	$24,053	XX	$28,899	XX	$24,466
Total	XX	976,368	XX	1,095,743	XX	1,149,107	XX	1,231,485
RHODE ISLAND								
Sand and gravel ... thousand short tons	2,480	3,015	2,387	2,913	2,252	3,052	2,079	3,336
Stone ... do	W	1,417	W	W	3	422	[4] 329	[4] 23
Value of items that cannot be disclosed: Other nonmetals and values indicated by symbol W	XX	1	XX	1,473	XX	825	XX	932
Total	XX	4,433	XX	4,386	XX	4,299	XX	4,291
SOUTH CAROLINA								
Clays ... thousand short tons	2,444	10,911	1,974	9,878	[3] 2,049	[3] 10,201	2,221	11,268
Sand and gravel ... do	5,692	8,229	5,864	7,766	6,438	9,119	7,916	12,121
Stone ... do	8,846	13,506	9,710	[4] 14,734	11,047	17,852	12,482	21,819
Value of items that cannot be disclosed: Cement, feldspar, kyanite (1969), scrap mica, peat, pyrites (1969), stone, and vermiculite	XX	23,218	XX	23,987	XX	29,716	XX	37,105
Total	XX	55,864	XX	56,365	XX	66,888	XX	82,313
SOUTH DAKOTA								
Beryllium concentrate ... short tons, gross weight	46	23	W	W	W	W	W	W
Cement:								
Portland ... thousand short tons	292	5,715	W	W	W	W	W	W
Masonry ... do	7	181	W	W	W	W	W	W
Clays ... do	187	1,171	165	946	[3] 150	[3] 128	[3] 185	[3] 156
Feldspar ... short tons	r 32,966	194	r 19,276	114	r 24,640	539	11,227	150
Gem stones	NA	36	NA	35	NA	40	NA	42
Gold (recoverable content of ores, etc.) ... troy ounces	593,146	24,621	578,716	21,059	513,427	21,179	407,430	23,875
Gypsum ... thousand short tons	11	46	15	61	21	83	24	43
Lead (recoverable content of ores, etc.) ... short tons	1	(5)	3	1	--	--	--	--
Mica (scrap) ... thousand short tons	(5)	20	(5)	34	W	W	W	W
Petroleum (crude) ... thousand 42-gallon barrels	158	362	160	374	233	604	219	574
Sand and gravel ... thousand short tons	11,158	10,807	16,556	16,656	16,727	18,392	12,748	14,793
Silver (recoverable content of ores, etc.) ... thousand troy ounces	124	223	120	212	107	165	100	168
Stone ... thousand short tons	2,092	10,839	1,979	13,375	2,199	8,874	2,665	10,864
Zinc (recoverable content of ores, etc.) ... short tons	--	--	1	(5)	--	--	--	--

Value of items that cannot be disclosed: Columbium-tantalum concentrate (1969), lime, lithium minerals (1969), tin (1969), uranium, vanadium (1970, 1972) and values indicated by symbol W	XX	683	XX	8,709	XX	12,984	XX	14,535
Total	XX	54,921	XX	61,576	XX	62,988	XX	65,200
TENNESSEE								
Barite ... thousand short tons	16	295	19	286	21	342	W	W
Cement:								
Portland ... do	1,722	29,403	1,669	29,832	1,713	33,733	1,695	37,176
Masonry ... do	186	3,587	136	2,749	159	3,649	176	4,104
Clays [3] ... do	1,719	7,064	1,401	7,123	1,537	6,595	1,718	7,719
Coal (bituminous) ... do	8,082	30,682	8,237	40,372	9,271	59,368	11,260	81,386
Copper (recoverable content of ores, etc.) ... short tons	15,353	14,596	15,535	17,928	13,916	14,473	11,310	11,581
Gold (recoverable content of ores, etc.) ... troy ounces	126	5	124	5	192	8	176	10
Natural gas ... million cubic feet	57	11	64	13	89	20	25	8
Petroleum (crude) ... thousand 42-gallon barrels	32	W	309	W	398	W	198	W
Phosphate rock ... thousand short tons	W	W	3,073	15,005	2,571	12,151	2,154	10,732
Sand and gravel ... do	6,175	9,709	6,715	10,639	8,018	11,845	10,839	15,328
Silver (recoverable content of ores, etc.) thousand troy ounces	79	141	95	168	131	203	83	141
Stone ... thousand short tons	33,265	46,192	35,374	50,013	32,369	48,665	35,942	55,512
Zinc (recoverable content of ores, etc.) ... short tons	124,532	36,363	118,260	36,233	119,295	38,413	101,722	36,111
Value of items that cannot be disclosed: Clay (fuller's earth), lime, pyrites, and values indicated by symbol W	XX	27,402	XX	10,099	XX	10,197	XX	10,006
Total	XX	205,450	XX	220,465	XX	239,662	XX	269,814
TEXAS								
Cement:								
Portland ... thousand short tons	6,715	117,989	6,386	122,960	7,198	140,206	7,813	171,642
Masonry ... do	155	3,873	141	3,769	169	4,514	217	5,812
Clays ... do	4,407	8,664	4,148	9,587	4,615	10,432	5,175	11,554
Coal (lignite) ... do	W	W	W	W	W	W	4,045	W
Gem stones	NA	150	NA	150	NA	155	NA	163
Gypsum ... thousand short tons	1,314	4,398	1,220	4,252	1,303	4,806	1,542	5,284
Helium:								
Crude ... million cubic feet	1,190	13,053	1,157	13,262	1,208	14,496	1,026	12,312
High-purity ... do	141	4,917	82	2,862	50	1,750	--	--
Lime ... thousand short tons	1,633	22,107	1,673	24,427	1,612	24,583	1,631	22,181
Natural gas ... million cubic feet	7,853,199	1,075,888	8,357,716	1,203,511	8,550,705	1,376,664	8,657,840	1,419,886
Natural gas liquids:								
Natural gasoline and cycle products thousand 42-gallon barrels	96,628	289,042	97,511	284,871	96,286	299,981	92,437	294,163
LPG ... do	194,599	237,411	204,177	334,850	210,435	380,887	226,624	428,319
Petroleum (crude) ... do	1,151,775	3,696,328	1,249,607	4,104,005	1,222,926	4,261,775	1,301,685	4,536,077
Perlite ... short tons	--	--	--	--	--	--	2,391	24
Pumice ... thousand short tons	W	W	W	W	4	4	W	W
Salt ... do	9,261	43,012	10,184	45,000	9,217	40,838	9,744	36,544
Sand and gravel ... do	29,972	39,756	31,438	46,362	32,788	51,814	35,151	56,328
Stone ... do	46,638	64,986	45,557	64,422	41,168	[4] 62,144	49,314	[4] 66,578
Sulfur (Frasch process) ... thousand long tons	2,552	68,360	2,801	62,290	[r] 3,092	W	3,847	W

See footnotes at end of table.

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

Mineral	1969 Quantity	1969 Value (thousands)	1970 Quantity	1970 Value (thousands)	1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
TEXAS—Continued								
Talc and soapstone ---- short tons	163,812	$668	171,420	$878	193,830	$1,024	221,022	$1,262
Value of items that cannot be disclosed: Native asphalt, bromine (1969), fluorspar (1972), graphite, iron ore, magnesium chloride (for metal), magnesium compounds (except for metal), mercury, sodium sulfate, uranium, vermiculite (1969), and values indicated by symbol W	XX	79,368	XX	74,541	XX	r 132,210	XX	143,427
Total	XX	5,769,970	XX	6,401,999	XX	r 6,808,283	XX	7,211,551
UTAH								
Carbon dioxide, natural ---- thousand cubic feet	64,839	5	60,754	4	55,178	4	61,103	4
Clays ---- thousand short tons	179	1,286	189	1,237	198	1,064	[3] 266	[3] 790
Coal (bituminous) ---- do	4,657	29,396	4,733	34,472	4,626	34,082	4,802	42,868
Copper (recoverable content of ores, etc.) ---- short tons	296,699	282,066	295,738	341,282	263,451	273,989	259,507	265,735
Fluorspar ---- do	6,667	207	19,214	595	10,947	341	2,977	84
Gem stones	NA	85	NA	85	NA	90	NA	95
Gold (recoverable content of ores, etc.) ---- troy ounces	433,385	17,990	408,029	14,848	368,996	15,221	362,413	21,237
Iron ore (usable) ---- thousand long tons, gross weight	1,921	12,552	1,990	13,837	1,681	11,886	1,788	W
Lead (recoverable content of ores, etc.) ---- short tons	41,332	12,313	45,377	14,175	38,270	10,562	20,706	6,224
Lime ---- thousand short tons	191	3,947	186	3,756	172	3,569	171	4,216
Manganiferous ore (5% to 35% Mn) ---- short tons	--	--	700	W	112	W	--	--
Natural gas ---- million cubic feet	46,733	7,197	42,781	6,460	42,418	7,084	39,474	6,711
Natural gas liquids:								
Natural gasoline and cycle products ---- thousand 42-gallon barrels	W	W	W	W	W	W	458	1,406
LPG ---- do	W	W	W	W	W	W	1,742	2,787
Petroleum (crude) ---- do	23,295	65,320	23,370	65,603	23,630	71,886	26,570	80,773
Pumice ---- thousand short tons	10	21	W	18	6	10	14	29
Salt ---- do	481	4,439	450	4,192	614	5,213	660	4,955
Sand and gravel ---- do	19,151	16,042	12,010	10,439	10,505	10,190	14,619	17,071
Silver (recoverable content of ores, etc.) ---- thousand troy ounces	5,954	10,661	6,030	10,678	5,294	8,185	4,300	7,245
Stone ---- thousand short tons	2,582	4,434	1,650	4,320	2,556	5,335	3,384	6,005
Tungsten concentrates ---- short tons, 60% WO_3 basis	3	6	W	W	W	W	W	W
Uranium (recoverable content U_3O_8) ---- thousand pounds	1,140	6,824	1,635	10,023	1,445	8,959	1,496	9,425
Vanadium (recoverable in ore and concentrate) ---- short tons	W	W	257	W	226	W	188	W
Zinc (recoverable content of ores, etc.) ---- do	34,902	10,191	34,688	10,628	25,701	8,276	21,853	7,758
Value of items that cannot be disclosed: Asphalt (gilsonite), beryl (1970–72), cement, certain clays (1972), gypsum, magnesium chloride (1972), magnesium compounds, molybdenum, perlite (1969–70), phosphate rock, potassium salts, sodium sulfate (1970–72), and values indicated by symbol W	XX	57,507	XX	55,899	XX	49,754	XX	57,391
Total	XX	542,489	XX	602,551	XX	525,700	XX	542,809

VERMONT								
Lime, thousand short tons	2	25	--	--	--	--	--	--
Peat, do	(5)	4	(5)	6	W	W	(5)	1
Sand and gravel, do	3,336	3,028	4,046	4,122	3,761	3,518	3,302	3,214
Stone, do	2,151	19,810	1,514	19,088	r 2,496	r 27,940	3,300	26,170
Talc, short tons	W	W	W	W	W	W	180,239	1,326
Value of items that cannot be disclosed: Asbestos, clays, gem stones, and values indicated by symbol W	XX	4,892	XX	4,627	XX	4,631	XX	4,157
Total	XX	27,759	XX	27,843	XX	r 36,089	XX	34,868
VIRGINIA								
Clays, thousand short tons	1,677	1,504	1,633	1,672	1,710	1,800	1,634	1,783
Coal (bituminous), do	35,555	192,802	35,016	246,181	30,628	254,870	34,028	344,061
Gem stones	NA	7	NA	7	NA	12	NA	13
Lead (recoverable content of ores, etc.), short tons	3,358	1,000	3,356	1,048	3,386	934	3,441	1,034
Lime, thousand short tons	1,072	13,653	1,046	14,090	759	11,049	758	11,739
Natural gas, million cubic feet	2,846	845	2,805	864	2,619	822	2,787	892
Petroleum (crude), thousand 42-gallon barrels	1	W	1	W	1	W	(5)	(5)
Sand and gravel, thousand short tons	12,140	15,954	11,126	15,229	12,796	20,201	14,085	21,696
Soapstone, short tons	4,600	12	3,760	9	3,704	8	W	W
Stone, thousand short tons	33,461	58,713	35,415	60,477	34,643	63,482	39,986	74,090
Zinc (recoverable content of ores, etc.), short tons	18,704	5,462	18,063	5,534	16,829	5,419	16,789	5,960
Value of items that cannot be disclosed: Aplite, cement, feldspar, gypsum, iron ore, kyanite, salt, titanium concentrate, and values indicated by symbol W	XX	27,575	XX	29,210	XX	26,564	XX	28,523
Total	XX	317,527	XX	374,321	XX	385,161	XX	489,791
WASHINGTON								
Cement:								
Portland, thousand short tons	1,195	22,724	1,221	24,832	1,149	23,735	1,239	26,848
Masonry, do	8	204	6	158	5	145	6	170
Clays [3], do	230	434	240	436	255	549	264	584
Coal (bituminous), do	58	480	37	470	1,134	7,614	2,635	17,424
Copper (recoverable content of ores, etc.), short tons	18	17	9	11	W	W	W	W
Gem stones	NA	150	NA	150	NA	155	NA	163
Gypsum, thousand short tons	W	W	--	--	W	W	5	13
Lead (recoverable content of ores, etc.), short tons	8,649	2,577	6,784	2,119	5,117	1,429	2,567	772
Peat, thousand short tons	33	134	17	71	17	72	18	89
Sand and gravel, do	34,245	31,046	25,089	27,902	22,702	26,658	23,065	26,069
Silver (recoverable content of ores, etc.), thousand troy ounces	W	W	W	W	W	W	221	372
Stone, thousand short tons	15,742	21,069	13,701	19,100	12,436	20,489	14,712	[4] 23,764
Talc and soapstone, short tons	4,228	W	W	W	W	W	W	W
Zinc (recoverable content of ores, etc.), do	9,738	2,843	11,956	3,663	5,782	1,862	6,483	2,301
Value of items that cannot be disclosed: Abrasives (1971), bauxite (1970), certain clays, diatomite, gold, lime, olivine, pumice, uranium (1970–72), and values indicated by symbol W	XX	6,948	XX	12,010	XX	r 11,893	XX	11,237
Total	XX	88,626	XX	90,922	XX	94,601	XX	109,806

See footnotes at end of table.

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

Mineral	1969 Quantity	1969 Value (thousands)	1970 Quantity	1970 Value (thousands)	1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
WEST VIRGINIA								
Clays [3] ... thousand short tons	247	$348	191	$238	232	$336	274	$403
Coal (bituminous) ... do	141,011	807,811	144,072	1,142,245	118,258	1,128,282	123,743	1,275,813
Gem stones	NA	W	NA	W	NA	2	NA	2
Lime ... thousand short tons	269	3,648	262	3,757	197	3,073	W	W
Natural gas ... million cubic feet	231,759	62,575	242,452	61,583	234,027	60,613	214,951	64,485
Petroleum (crude) ... thousand 42-gallon barrels	3,104	11,888	3,124	11,871	2,969	11,609	2,677	12,047
Salt ... thousand short tons	1,309	4,978	1,190	5,171	1,174	4,778	1,232	5,963
Sand and gravel ... do	5,021	11,475	4,396	11,473	7,107	16,756	5,765	15,031
Stone [4] ... do	9,031	15,801	9,740	16,722	9,880	18,066	11,649	21,293
Value of items that cannot be disclosed: Cement, fire clay, natural gas liquids, stone, and values indicated by symbol W	XX	28,715	XX	32,304	XX	30,445	XX	35,595
Total	XX	947,239	XX	1,285,364	XX	1,273,960	XX	1,430,632
WISCONSIN								
Clays ... thousand short tons	12	24	8	14	4	8	4	7
Gem stones	NA	W	NA	W	NA	W	NA	1
Iron ore (usable) ... thousand long tons, gross weight	36	W	806	W	824	W	887	W
Lead (recoverable content of ores, etc.) ... short tons	1,102	328	761	238	752	207	757	228
Lime ... thousand short tons	244	4,080	247	4,503	246	4,570	263	5,009
Peat ... do	2	155	2	W	2	153	2	179
Sand and gravel ... do	42,815	35,414	41,103	35,107	38,561	32,748	36,430	31,324
Stone ... do	18,954	27,571	17,577	25,167	15,568	25,105	19,394	29,681
Zinc (recoverable content of ores, etc.) ... short tons	22,901	6,687	20,634	6,322	10,645	3,428	6,873	2,440
Value of items that cannot be disclosed: Abrasive stones, cement, and value indicated by symbol W	XX	5,533	XX	16,319	XX	17,817	XX	20,484
Total	XX	79,792	XX	87,670	XX	84,036	XX	89,353
WYOMING								
Clays ... thousand short tons	1,992	18,970	1,950	18,829	1,798	17,378	1,873	18,509
Coal (bituminous) ... do	4,602	15,443	7,222	24,423	8,052	27,335	10,928	40,898
Gem stones	NA	129	NA	130	NA	135	NA	142
Gypsum ... thousand short tons	W	W	216	868	232	918	W	W
Iron ore (usable) ... thousand long tons, gross weight	2,048	20,751	W	W	1,808	W	2,030	W
Lime ... thousand short tons	27	W	22	W	27	W	W	W
Natural gas ... million cubic feet	303,517	44,617	338,520	49,762	380,105	58,156	375,059	60,760
Natural gas liquids:								
Natural gasoline ... thousand 42-gallon barrels	2,523	7,051	2,597	7,085	2,514	7,415	3,015	8,951
LPG ... do	4,428	7,085	4,556	7,472	5,474	10,127	7,691	15,536
Petroleum (crude) ... do	154,945	433,846	160,345	469,811	148,114	459,079	140,011	432,071
Sand and gravel ... thousand short tons	7,568	7,288	9,447	9,298	9,820	8,750	9,098	14,916
Stone ... do	1,584	3,012	1,266	2,758	2,894	4,789	3,549	5,768
Uranium (recoverable content U_3O_8) ... thousand pounds	6,716	40,318	6,346	38,768	6,986	43,311	8,544	53,827

Value of items that cannot be disclosed: Cement, copper (1969), feldspar (1970–72), gold (1969), phosphate rock, pumice, (1969, 1972), sodium carbonate, sodium sulfate (1969–70), and values indicated by symbol W	XX	48,933	XX	76,329	XX	80,544	XX	95,365
Total	XX	647,443	XX	705,533	XX	717,937	XX	746,743

[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] Excludes salt in brine, included with "Value of items that cannot be disclosed."

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

Area and mineral	1969 Quantity	1969 Value (thousands)	1970 Quantity	1970 Value (thousands)	1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
American Samoa:								
Pumice__thousand short tons__	2	$5	2	$6	10	$35	--	--
Sand and gravel________do____	7	7	26	25	--	--	--	--
Stone________________do____	54	108	49	69	33	30	49	414
Total____________________	XX	120	XX	100	XX	65	XX	414
Canal Zone:								
Sand and gravel thousand short tons__	60	97	60	97	--	--	--	--
Stone________________do____	74	231	85	265	--	--	--	--
Total____________________	XX	328	XX	362	XX	--	XX	--
Guam: Stone_thousand short tons__	654	1,399	636	1,289	718	1,705	831	1,983
Virgin Islands: Stone_______do____	411	1,682	514	2,226	r 543	W	726	2,255
Wake: Stone______________do____	9	45	4	18	r 3	16	--	--

r Revised. 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).

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

Mineral	1969 Quantity	1969 Value (thousands)	1970 Quantity	1970 Value (thousands)	1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
Cement__thousand short tons__	1,681	$27,920	1,778	$29,515	2,001	$38,413	1,946	$31,756
Clays________________do____	438	454	429	486	342	358	361	382
Lime_________________do____	41	1,505	41	W	44	W	42	1,776
Salt_________________do____	32	395	32	395	29	570	29	580
Sand and gravel________do____	9,432	23,296	11,506	28,001	r 12,998	r 34,980	7,478	21,237
Stone________________do____	6,985	13,550	7,296	13,947	12,130	29,847	13,504	32,793
Total________________	XX	67,120	XX	[2] 72,344	XX	[2] r 104,168	XX	88,524

r Revised. 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] Total does not include value of items withheld.

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

Mineral	1971		1972	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Metals:				
Aluminum:				
Ingots, slabs, crude____short tons__	112,295	$58,040	108,319	$51,879
Scrap____do____	30,675	9,995	66,039	21,072
Plates, sheets, bars, etc____do____	r 141,133	r 111,827	144,987	115,279
Castings and forgings____do____	3,561	8,245	4,467	11,681
Aluminum sulfate____do____	16,840	568	4,968	181
Other aluminum compounds____do____	r 1,142,980	r 96,885	942,084	83,490
Antimony: Metals and alloys crude____do____	1,023	761	121	85
Bauxite, including bauxite concentrates thousand long tons__	34	1,529	29	1,299
Beryllium____pounds__	41,114	1,051	95,492	839
Bismuth: Metals and alloys____do____	71,187	199	264,276	493
Cadmium____thousand pounds__	66	172	1,017	2,363
Chrome:				
Ore and concentrates:				
Exports____thousand short tons__	35	2,094	20	824
Reexports____do____	145	6,081	57	1,946
Ferrochrome____do____	9	3,620	13	4,342
Cobalt____thousand pounds__	1,212	2,108	2,597	5,005
Columbium metals, alloys and other forms_do____	21	588	29	453
Copper:				
Ore, concentrate, composition metal and unrefined (copper content)____short tons__	36,824	30,672	35,562	26,548
Refined copper and semimanufactures_do____	215,705	267,303	215,591	278,059
Other copper manufactures____do____	7,746	9,145	6,299	7,400
Copper sulfate or blue vitriol____do____	2,815	2,078	2,646	1,767
Copper base alloys____do____	r 97,975	r 106,840	90,377	105,586
Ferroalloys:				
Ferrosilicon____do____	25,506	5,603	7,367	2,196
Ferrophosphorous____do____	35,111	1,419	1,179	111
Gold:				
Ore and base bullion____troy ounces__	577,502	23,470	265,783	14,531
Bullion, refined____do____	761,302	27,779	1,206,386	48,522
Iron ore____thousand long tons__	3,061	38,147	2,095	26,776
Iron and steel:				
Pig iron____short tons__	34,164	2,352	15,018	931
Iron and steel products (major):				
Semimanufactures____do____	r 2,505,864	r 405,533	2,309,583	400,820
Manufactured steel mill products_do____	r 1,020,206	538,994	1,236,897	605,600
Iron and steel scrap: Ferrous scrap, including rerolling materials___thousand short tons__	6,653	222,222	7,683	252,617
Lead:				
Pigs, bars, anodes____short tons__	5,925	3,889	8,376	4,500
Scrap____do____	r 17,091	r 2,268	35,233	4,264
Magnesium: Metal and alloys and semimanufactured forms, n.e.c____do____	24,311	15,692	17,556	11,702
Manganese:				
Ore and concentrate____do____	55,413	2,683	25,108	3,137
Ferromanganese____do____	4,526	1,205	6,842	1,512
Mercury:				
Exports____76-pound flasks__	7,232	2,789	400	129
Reexports____do____	--	--	563	121
Molybdenum:				
Ore and concentrates (molybdenum content) thousand pounds__	46,284	79,111	45,362	73,039
Metals and alloys, crude and scrap___do____	222	227	89	199
Wire____do____	140	1,212	173	1,551
Semifabricated forms, n.e.c____do____	623	1,195	181	987
Powder____do____	41	170	50	192
Ferromolybdenum____do____	1,355	1,978	509	1,163
Nickel:				
Alloys and scrap (including Monel metal), ingots, bars, sheets, etc____short tons__	18,923	48,503	16,694	42,677
Catalysts____do____	3,740	10,018	2,573	6,794
Nickel-chrome electric resistance wire_do____	643	3,269	553	2,638
Semifabricated forms, n.e.c____do____	2,837	12,780	1,851	11,659
Platinum:				
Ore, concentrate, metal and alloys in ingots, bars, sheets, anodes, and other forms, including scrap____troy ounces__	320,842	29,432	417,037	44,256
Palladium, rhodium, iridium, osmiridium, ruthenium, and osmium (metal and alloys including scrap)____do____	83,768	4,021	121,949	7,511
Platinum-group manufactures, except jewelry	NA	4,769	NA	4,255

See footnotes at end of table.

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

Mineral	1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
Metals—Continued				
Rare-earth elements:				
Cerium ore, metal, alloys and lighter flints pounds	60,044	$164	202,206	$610
Silver:				
Ore, concentrates, waste and sweepings thousand troy ounces	3,728	6,164	2,964	4,899
Bullion, refined do	8,496	13,634	26,693	44,361
Tantalum:				
Ore, metal, and other forms thousand pounds	242	2,611	162	2,308
Powder do	85	2,519	171	3,572
Tin:				
Ingots, pigs, bars, etc.:				
Exports long tons	1,821	6,648	857	2,915
Reexports do	441	1,620	277	1,055
Tin scrap and other tin-bearing material except tinplate scrap do	2,605	1,780	8,548	3,392
Titanium:				
Ore and concentrate short tons	1,760	299	1,802	394
Sponge (including iodide titanium and scrap) do	1,711	1,139	3,510	2,165
Intermediate mill shapes and mill products, n.e.c do	430	4,788	562	6,265
Dioxide and pigments do	26,759	9,378	10,334	4,882
Tungsten: Ore and concentrates:				
Exports thousand pounds	2,006	7,323	95	211
Reexports do	1	1	--	--
Vanadium ore and concentrate, pentoxide, etc. (vanadium content) do	520	1,834	351	756
Zinc:				
Slabs, pigs, or blocks short tons	13,346	2,337	4,324	714
Sheets, plates, strips, or other forms, n.e.c do	1,686	1,486	2,419	2,138
Scrap (zinc content) do	2,000	504	1,446	431
Semifabricated forms, n.e.c do	6,042	2,709	6,052	3,076
Zirconium:				
Ore and concentrate do	9,429	802	17,360	940
Metals and alloys and other forms pounds	1,125,242	13,054	1,314,219	11,509
Nonmetals:				
Abrasives:				
Dust and powder of precious or semiprecious stones, including diamond dust and powder thousand carats	7,506	18,726	8,263	21,986
Crushing bort do	20	94	55	305
Industrial diamond do	415	1,831	484	1,889
Diamond grinding wheels do	526	2,932	554	3,073
Other natural and artificial, metallic abrasives and products	NA	37,102	NA	36,956
Asbestos, unmanufactured:				
Exports short tons	52,202	7,571	51,792	7,621
Reexports do	1,476	292	6,832	1,430
Boron: Boric acid, borates, crude and refined do	202,496	24,411	189,778	22,530
Cement do	r 109,566	r 3,463	100,889	3,712
Clays:				
Kaolin or china clay do	673,083	26,125	667,519	26,332
Fire clay do	161,934	3,566	124,307	2,905
Other clays do	1,137,723	35,638	1,053,892	36,979
Fluorspar do	12,491	525	2,764	184
Graphite do	5,733	680	7,289	888
Gypsum:				
Crude, crushed or calcined thousand short tons	r 49	2,318	51	2,582
Manufactures, n.e.c	NA	1,896	NA	2,694
Kyanite and allied minerals short tons	31,554	2,097	73,911	3,737
Lime do	65,862	1,971	37,659	1,242
Mica sheet, waste and scrap and ground pounds	14,383,388	1,209	13,957,313	1,842
Mica, manufactured do	798,956	2,559	1,001,639	2,910
Mineral-earth pigments: Iron oxide, natural and manufactured short tons	r 10,545	r 5,812	8,194	5,087
Nitrogen compounds (major) thousand short tons	3,126	141,381	4,004	222,441
Phosphate rock do	12,687	94,816	13,992	107,438

See footnotes at end of table.

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

Mineral	1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
Nonmetals—Continued				
Phosphatic fertilizers (superphosphates) thousand short tons	r 748	r $30,391	967	$52,465
Pigments and compounds (lead and zinc):				
Lead pigments short tons	1,955	833	1,867	818
Zinc pigments do	7,229	2,864	7,567	2,764
Potash:				
Fertilizer do	1,032,948	35,323	1,353,471	45,858
Chemical do	r 33,177	r 6,765	31,435	6,890
Quartz, natural, quartzite, cryolite and chiolite do	431	54	677	130
Salt:				
Crude and refined thousand short tons	670	4,182	869	5,544
Shipments to noncontiguous Territories do	19	1,898	21	2,303
Sodium and sodium compounds:				
Sodium sulfate do	66	1,825	29	926
Sodium carbonate do	437	15,400	480	18,914
Stone:				
Dolomite, block do	87	1,639	77	1,025
Limestone, crushed, ground, broken do	r 1,823	r 3,752	1,730	3,802
Marble and other building and monumental thousand cubic feet	NA	905	NA	755
Stone, crushed, ground, broken thousand short tons	585	3,871	1,035	4,298
Manufactures of stone	NA	1,322	NA	1,227
Sulfur:				
Crude thousand long tons	1,532	27,844	1,847	32,409
Crushed, ground, flowers of do	4	1,019	5	1,278
Talc, crude and ground short tons	135,881	4,844	171,007	5,791
Fuels:				
Carbon black thousand pounds	163,246	20,425	111,328	14,924
Coal:				
Anthracite thousand short tons	671	10,104	743	10,922
Bituminous do	56,633	891,484	55,960	971,232
Briquets do	72	4,335	75	4,285
Coke do	1,509	44,819	1,232	30,720
Natural gas thousand cubic feet	84,196,444	38,430	89,499,088	42,176
Petroleum:				
Crude thousand barrels	503	1,563	192	565
Gasoline do	1,783	15,259	493	4,396
Jet do	211	898	258	3,055
Naphtha do	1,593	16,401	1,438	34,242
Kerosine do	172	1,356	84	778
Distillate oil do	2,869	12,328	755	3,055
Residual oil do	13,162	40,991	11,576	34,349
Lubricating oil do	15,218	183,032	12,149	169,424
Asphalt do	304	3,449	304	3,572
Liquefied petroleum gases do	9,379	29,235	11,475	46,581
Wax do	1,638	36,017	1,105	25,840
Coke do	26,823	106,594	30,667	111,950
Petrochemical feedstocks do	5,243	27,555	4,605	23,414
Miscellaneous do	1,006	20,132	1,042	17,073
Total	XX	r 4,357,478	XX	4,648,087

r Revised. NA Not available. XX Not applicable.

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

Mineral	1971		1972	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Metals:				
Aluminum:				
Metal ... short tons	554,208	$257,473	661,042	$304,536
Scrap ... do	62,840	r 22,004	52,301	17,747
Plates, sheets, bars, etc ... do	70,944	45,702	78,951	50,209
Aluminum oxide (alumina) ... do	r 2,410,191	r 141,904	2,849,995	173,413
Antimony:				
Ore (antimony content) ... do	9,619	8,787	17,212	9,437
Needle or liquated ... do	32	47	78	75
Metal ... do	1,638	1,914	2,302	2,092
Oxide ... do	2,791	4,317	5,032	5,766
Arsenic: White (As_2O_3 content) ... do	r 17,306	2,187	13,613	1,956
Bauxite: Crude ... thousand long tons	12,326	153,639	11,428	151,012
Beryllium ore ... short tons	4,026	1,475	3,345	1,101
Bismuth ... pounds	848,708	4,050	1,562,934	5,235
Boron carbide ... do	18,298	56	11,622	61
Cadmium:				
Metal ... thousand pounds	3,499	6,264	2,422	4,886
Flue dust (cadmium content) ... do	1,112	1,118	741	685
Calcium:				
Metal ... pounds	48,391	30	248,080	184
Chloride ... short tons	13,019	544	6,128	225
Chromate:				
Ore and concentrates (Cr_2O_3 content) thousand short tons	590	r 31,873	501	27,627
Ferrochrome ... do	54	22,697	90	34,588
Metal ... do	2	2,966	2	3,791
Cobalt:				
Metal ... thousand pounds	10,381	r 22,377	13,082	30,650
Oxide (gross weight) ... do	726	1,426	1,134	2,330
Salts and compounds (gross weight) do	40	27	82	44
Columbium ore ... do	3,054	2,222	3,227	1,927
Copper: (copper content)				
Ore and concentrates ... short tons	5,547	4,091	80,740	81,055
Regulus, black, coarse ... do	119	220	1,453	1,134
Unrefined, black, blister ... do	153,625	144,395	77,162	72,514
Refined in ingots, etc ... do	163,988	r 165,300	175,703	172,772
Old and scrap ... do	7,459	6,679	10,787	9,766
Ferroalloys: Ferrosilicon (silicon content) do	r 12,683	r 5,750	23,154	8,815
Gold:				
Ore and base bullion ... troy ounces	191,470	7,264	265,453	14,023
Bullion ... do	7,009,241	276,683	5,860,749	343,666
Iron ore ... thousand long tons	40,124	450,644	35,761	415,934
Iron and steel:				
Pig iron ... short tons	306,320	16,964	636,932	33,518
Iron and steel products (major):				
Iron products ... do	37,519	13,964	41,428	18,158
Steel products ... do	r 18,706,757	r 2,788,825	18,117,041	2,965,950
Scrap ... do	263,192	10,713	295,000	14,304
Tinplate ... do	20,239	546	17,040	437
Lead:				
Ore, flue dust, matte (lead content) do	88,184	19,362	51,642	10,554
Base bullion (lead content) ... do	41	16	895	238
Pigs and bars (lead content) ... do	192,570	48,021	245,598	64,096
Reclaimed scrap, etc. (lead content) do	2,518	579	1,753	450
Sheet, pipe and shot ... do	237	86	142	52
Magnesium:				
Metallic and scrap ... do	3,442	1,633	4,298	1,990
Alloys (magnesium content) ... do	99	286	168	464
Sheets, tubing, ribbons, wire and other forms (magnesium content) do	130	397	13	103
Manganese:				
Ore (35% or more manganese) (manganese content) ... do	r 938,122	42,184	792,695	34,315
Ferromanganese (manganese content) ... do	189,260	32,392	274,717	49,846
Mercury:				
Compounds ... pounds	1,220	9	9,028	45
Metal ... 76-pound flasks	28,449	8,165	28,834	6,211

See footnotes at end of table.

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

Mineral	1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
Metals—Continued				
Minor metals: Selenium and salts ....pounds..	409,264	$4,134	448,964	$4,362
Nickel:				
Pigs, ingots, shot, cathodes ....short tons..	100,531	259,931	125,364	300,825
Scrap........do....	1,336	1,896	2,306	3,517
Oxide........do....	5,769	11,604	5,988	12,038
Platinum group:				
Unwrought:				
Grains and nuggets (platinum) ....troy ounces..	34,958	3,170	58,284	7,254
Sponge (platinum)........do....	[r] 329,967	[r] 36,882	350,143	42,622
Sweepings, waste and scrap ....do....	75,031	7,477	75,210	7,600
Iridium........do....	14,293	1,908	24,827	4,038
Palladium........do....	[r] 220,883	[r] 7,919	289,055	12,929
Rhodium........do....	33,764	5,980	47,378	8,735
Ruthenium........do....	28,063	1,222	61,191	2,602
Other platinum-group metals ....do....	15,037	2,067	103,734	12,148
Semimanufactured:				
Platinum........do....	105,806	11,475	207,960	22,869
Palladium........do....	442,465	15,198	613,174	22,488
Rhodium........do....	898	169	3,426	543
Other platinum-group metals ....do....	1,575	207	6,920	473
Radium: Radioactive substitutes........	NA	5,671	NA	4,444
Rare-earth elements: Ferrocerium and other cerium alloys........pounds..	16,190	82	27,867	94
Silver:				
Ore and base bullion ....thousand troy ounces..	33,452	45,003	33,768	49,979
Bullion........do....	22,388	33,979	25,680	41,579
Tantalum ore........thousand pounds..	1,180	3,332	1,229	2,663
Tin:				
Ore (tin content)........long tons..	3,060	10,564	4,216	12,475
Blocks, pigs, grains, etc........do....	46,940	164,403	52,451	195,421
Dross, skimmings, scrap, residues and tin alloys, n.s.p.f........do....	4,125	1,385	1,304	2,140
Tin foil, powder, flitters, etc........	NA	[r] 4,472	NA	6,501
Titanium:				
Ilmenite [1]........short tons..	378,049	10,459	395,218	14,237
Rutile........do....	215,109	23,155	195,068	21,733
Metal........pounds..	6,594,448	6,355	8,769,356	8,041
Ferrotitanium........do....	173,057	154	181,326	76
Compounds and mixtures........do....	86,230,153	16,125	173,597,069	33,908
Tungsten: (tungsten content)				
Ore and concentrates ....thousand pounds..	418	1,033	5,739	12,139
Metal........do....	17	117	61	342
Other alloys........do....	129	1,804	644	2,902
Zinc:				
Ore (zinc content)........short tons..	467,368	62,678	174,063	24,275
Blocks, pigs, and slabs........do....	[r] 324,255	[r] 93,628	516,643	176,707
Sheets........do....	509	237	485	310
Old, dross, and skimmings........do....	1,967	287	2,882	2,170
Dust........do....	8,184	2,949	9,197	3,822
Manufactures........	NA	1,347	NA	2,040
Zirconium: Ore, including zirconium sand ....do....	96,387	3,656	67,537	3,291
Nonmetals:				
Abrasives: Diamond (industrial) ....thousand carats..	12,910	46,023	15,134	52,619
Asbestos........short tons..	681,367	80,090	735,515	87,732
Barite:				
Crude and ground........do....	484,762	4,490	624,634	5,658
Witherite........do....	511	42	1,311	169
Chemicals........do....	7,800	1,299	23,592	3,959
Cement........do....	[r] 3,088	44,348	4,894	71,530
Clays:				
Raw........do....	58,965	1,289	62,576	1,095
Manufactured........do....	5,084	212	4,138	214
Cryolite........do....	23,127	5,056	25,642	3,451

See footnotes at end of table.

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

Mineral	1971		1972	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Nonmetals—Continued				
Feldspar: Crude ---------- long tons --	120	$19	167	$23
Fluorspar ---------- short tons --	1,072,405	34,530	1,181,533	47,851
Gem stones:				
Diamond ---------- thousand carats --	4,667	463,242	5,506	626,679
Emeralds ---------- do ----	351	7,731	573	22,176
Other ----------	NA	55,010	NA	67,281
Graphite ---------- short tons --	r 57,756	2,727	64,135	3,847
Gypsum:				
Crude, ground, calcined thousand short tons --	6,096	13,552	7,720	18,494
Manufactures ----------	NA	2,780	NA	3,548
Iodine, crude ---------- thousand pounds --	7,275	11,510	6,207	10,184
Kyanite ---------- short tons --	1,343	65	124	6
Lime:				
Hydrated ---------- do ----	39,807	618	37,468	724
Other ---------- do ----	202,477	2,690	210,995	3,224
Magnesium compounds:				
Crude magnesite ---------- short tons --	7	(2)	--	--
Lump, ground, caustic calcined magnesia ---------- do ----	11,518	736	10,376	675
Refractory magnesia, dead-burned fused magnesite, dead-burned dolomite ---------- do ----	129,025	10,014	133,734	9,695
Compounds ---------- do ----	49,731	1,257	25,301	1,111
Mica:				
Uncut sheet and punch thousand pounds --	1,355	1,171	1,494	1,162
Scrap ---------- do ----	7,284	171	2,641	62
Manufactures ---------- do ----	4,464	2,476	5,644	3,183
Mineral-earth pigments: Iron oxide pigments:				
Natural ---------- short tons --	1,794	171	2,777	236
Synthetic ---------- do ----	28,236	5,592	34,274	7,602
Ocher, crude and refined ---- do ----	--	--	93	6
Siennas, crude and refined --- do ----	1,427	125	1,272	196
Umber, crude and refined --- do ----	4,681	228	8,234	412
Vandyke brown ---------- do ----	358	39	621	77
Nitrogen compounds (major), including urea ---------- thousand short tons --	2,573	118,281	2,683	125,037
Phosphate, crude ---------- do ----	84	2,478	57	1,544
Phosphatic fertilizers ---------- do ----	92	6,972	70	3,184
Pigments and salts:				
Lead pigments and compounds short tons --	r 27,893	r 7,647	26,550	9,244
Zinc pigments and compounds do ----	r 20,913	4,187	25,934	6,891
Potash ---------- do ----	4,687,379	118,481	4,996,415	128,548
Pumice:				
Crude or unmanufactured --- do ----	8,833	109	9,094	149
Wholly or partly manufactured do ----	390,900	975	589,758	1,351
Manufactures, n.s.p.f ----------	NA	18	NA	24
Quartz crystal (Brazillian pebble) pounds --	752,001	368	462,740	331
Salt ---------- thousand short tons --	3,855	14,429	3,463	11,979
Sand and gravel:				
Glass sand ---------- do ----	48	243	49	201
Other sand and gravel ---------- do ----	667	984	712	1,178
Sodium sulfate ---------- do ----	r 268	4,667	299	5,358
Stone and whiting ----------	NA	33,643	NA	43,472
Strontium: Mineral ---------- short tons --	45,505	1,115	30,677	830
Sulfur and pyrites:				
Sulfur ore and other forms n.e.s. thousand long tons --	r 1,299	25,419	1,138	16,288
Pyrites ---------- do ----	285	962	125	472
Talc: Unmanufactured ----- short tons --	17,382	745	29,085	1,669
Fuels:				
Carbon black:				
Acetylene ---------- pounds --	6,125,541	1,405	6,022,118	1,581
Gas black and carbon black -- do ----	386,246	41	1,149,099	176
Coal:				
Bituminous, slack, culm and lignite short tons --	111,036	1,772	47,098	691

See footnotes at end of table.

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

Mineral	1971		1972	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Fuels—Continued				
Coal—Continued				
Briquets__________short tons____	4,145	$63	5,849	$96
Coke_____________________do____	173,914	5,038	185,023	4,649
Natural gas, ethane, methane, and mixtures thereof____thousand cubic feet__	1,115,381,461	312,067	1,307,679,012	402,979
Peat:				
Fertilizer grade________short tons__	293,810	14,988	307,233	16,951
Poultry and stable grade____do____	2,473	154	3,258	222
Petroleum:				
Crude petroleum_thousand barrels__	670,972	1,687,279	896,991	2,369,176
Distillate__________________do____	36,108	103,227	107,905	254,529
Residual___________________do____	r 498,711	r 1,109,596	479,929	1,170,172
Unfinished oils_____________do____	4,801	12,292	1,812	5,324
Gasoline___________________do____	353	1,684	1,744	8,730
Jet fuel___________________do____	r 57,254	r 182,912	65,674	223,084
Motor fuels, n.e.s__________do____	1,127	3,538	171	669
Kerosine___________________do____	211	779	270	1,299
Lubricants_________________do____	14	593	702	987
Wax_______________________do____	96	505	73	1,342
Naphtha___________________do____	69,066	169,273	86,279	213,857
Liquefied petroleum gases___do____	26,247	57,208	32,485	73,340
Asphalt____________________do____	r 7,428	16,242	9,653	23,852
Miscellaneous______________do____	4,241	15,088	10,573	36,810
Total________________________	XX	r 10,481,151	XX	12,459,466

r Revised. NA Not available. XX Not applicable.
[1] Includes titanium slag averaging about 70% TiO_2. For detail see Titanium Chapter, table 9.
[2] Less than ½ unit.

Table 11.—Comparison of world and United States production of principal metals and minerals

(Thousand short tons unless otherwise specified)

Mineral	1971 r World production [1]	1971 r U.S. production	1971 r U.S.% of world production	1972 p World production [1]	1972 p U.S. production	1972 p U.S.% of world production
MINERAL FUELS						
Carbon black thousand pounds	6,276,475	3,017,135	48	6,581,354	3,201,109	49
Coal:						
Bituminous [2]	2,241,737	545,790	24	2,272,827	584,387	26
Lignite	881,479	6,402	1	887,065	10,999	1
Pennsylvania anthracite	198,653	8,727	4	195,933	7,106	4
Coke (excluding breeze):						
Gashouse [3]	24,688	--	--	22,972	--	--
Oven and beehive	372,979	57,436	15	374,593	60,507	16
Natural gas (marketable) million cubic feet	40,252,299	22,493,012	56	42,481,435	22,531,698	53
Peat	89,610	605	1	89,338	577	1
Petroleum (crude) thousand barrels	17,674,726	3,453,914	20	18,583,783	3,455,368	19
NONMETALS						
Asbestos	3,951	131	3	4,083	132	3
Barite	4,231	825	20	4,260	906	21
Cement	667,614	[4] 81,223	12	702,666	[4] 83,697	12
China clay	14,245	[5] 4,885	34	15,224	[5] 5,318	35
Corundum	8	--	--	9	--	--
Diamond thousand carats	41,102	--	--	43,155	--	--
Diatomite	1,712	535	31	1,727	576	33
Feldspar	2,749	743	27	2,635	732	28
Fluorspar	5,244	272	5	5,150	250	5
Graphite	432	W	NA	394	W	NA
Gypsum	58,552	10,418	18	63,545	12,328	19
Lime (sold or used by producers)	106,456	[4] 19,635	18	109,447	[4] 20,332	19
Magnesite	9,975	W	NA	9,764	W	NA
Mica (including scrap) thousand pounds	375,554	254,185	68	440,016	320,014	73
Nitrogen, agricultural [6]	36,305	[4] 8,996	25	38,693	[4] 9,169	24
Phosphate rock	96,040	38,886	40	103,866	40,831	39
Potash (K_2O equivalent)	21,818	2,588	12	22,465	2,659	12
Pumice [7]	17,417	3,401	20	17,660	3,819	22
Pyrites thousand long tons	21,457	808	4	20,022	741	3
Salt	158,933	[4] 44,106	28	162,560	[4] 45,050	28
Strontium	121	--	--	119	--	--
Sulfur, elemental thousand long tons	22,722	8,620	38	25,795	9,218	36
Talc, pyrophyllite, and soapstone	5,207	1,037	20	5,252	1,107	21
Vermiculite [7]	459	301	66	512	337	66
METALS, MINE BASIS						
Antimony (content of ore and concentrate) short tons	70,891	1,025	1	75,035	489	1
Arsenic, white	55	W	NA	50	W	NA
Bauxite thousand long tons	62,506	[8] 1,988	3	64,844	[8] 1,812	3
Beryllium concentrate short tons	5,844	W	NA	4,740	W	NA
Bismuth thousand pounds	8,442	W	NA	8,794	W	NA
Cadmium do	34,241	[9] 7,930	23	36,599	[9] 8,290	23
Chromite	6,908	--	--	6,840	--	--
Cobalt (contained)	24	W	NA	26	W	NA
Columbium-tantalum concentrates [7] thousand pounds	24,014	--	--	34,953	--	--
Copper (content of ore and concentrate)	6,653	[10] 1,522	23	7,314	[10] 1,665	23
Gold thousand troy ounces	46,491	1,495	3	44,712	1,450	3
Iron ore thousand long tons	766,758	[11] 80,762	11	756,488	[11] 75,434	10
Lead (content of ore and concentrate)	3,772	579	15	3,849	619	16
Manganese ore (35% or more Mn)	23,170	(12)	(12)	22,832	1	(12)
Mercury thousand 76-pound flasks	299	18	6	279	7	3
Molybdenum (content of ore and concentrate) thousand pounds	170,840	109,592	64	175,250	112,132	64
Nickel (content of ore and concentrate)	700	17	2	698	17	2
Platinum group (Pt., Pd., etc.) thousand troy ounces	4,084	18	(12)	4,613	17	(12)
Silver do	298,783	41,564	14	301,291	37,233	13
Tin (content of ore and concentrate) long tons	232,232	W	NA	239,602	W	NA

See footnotes at end of table.

Table 11.—Comparison of world and United States production of principal metals and minerals—Continued

(Thousand short tons unless otherwise specified)

Mineral	1971 r			1972 p		
	World production [1]	U.S. production	U.S.% of world production	World production [1]	U.S. production	U.S.% of world production
METALS, MINE BASIS—Continued						
Titanium concentrates:						
Ilmenite [7]	3,705	714	19	3,586	726	20
Rutile [7]	424	--	--	357	--	--
Tungsten concentrate (contained tungsten) thousand pounds	80,744	6,900	9	84,793	8,150	10
Vanadium (content of ore and concentrate) short tons	18,571	5,252	28	19,949	4,887	24
Zinc (content of ore and concentrate)	6,155	491	8	6,158	478	8
METALS, SMELTER BASIS						
Aluminum	11,375	3,925	35	12,103	4,122	34
Copper	6,739	[13] 1,500	22	7,300	[13] 1,690	23
Iron, pig	473,914	81,382	17	498,754	88,864	18
Lead	3,501	[14] 650	19	3,725	[14] 696	19
Magnesium	256	123	48	256	121	47
Selenium [7] thousand pounds	2,527	657	26	2,642	769	29
Steel ingots and castings	639,865	[15] 120,443	19	691,551	[15] 133,241	19
Tellurium [7] thousand pounds	340	164	48	422	257	61
Tin long tons	231,901	[16] 4,000	2	236,185	[16] 4,000	2
Uranium oxide (U_3O_8) [7] short tons	23,921	12,273	51	27,277	13,667	50
Zinc	5,175	766	15	5,615	633	11

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

[1] Total is not strictly comparable with previous years because it does not represent total world production. Confidential U.S. data are excluded. These data include reported figures and reasonable estimates. In some instances where data were not available, no reasonable estimate could be made and none has been included except for gold, silver and pyrites.

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

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

[4] Includes Puerto Rico.

[5] Kaolin sold or used by producers.

[6] Year ended June 30 of year stated (United Nations).

[7] World total exclusive of the U.S.S.R.

[8] Dry bauxite equivalent of crude ore.

[9] Includes secondary.

[10] Recoverable.

[11] Includes byproduct ore.

[12] Less than ½ unit.

[13] Smelter output from domestic and foreign ores, exclusive of scrap. Production from domestic ores only, exclusive of scrap, was as follows: 1970—1,605,265; 1971—1,470,815; 1972—1,649,130.

[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 ingots.

[16] Includes tin content of alloys made directly from ores.

Abrasive Materials

By Robert G. Clarke [1]

The output of natural abrasives increased 15% in quantity compared to that of 1971, and the value increased 12%, excluding the value of emery. Production of tripoli types increased 17% in quantity and 40% in value. Output of silica stone products increased 38% in quantity and 19% in value. The production of garnet was essentially unchanged in quantity but increased 1% in value. The production of emery increased 82% in quantity.

The production of artificial abrasives increased in both quantity and value for all types. Production of aluminum oxide increased 23% in quantity and 17% in value. Production of silicon carbide increased 28% in quantity and 17% in value. Production of metallic abrasives increased 22% in quantity and 19% in value. The overall increases for artificial abrasives were 24% in quantity and 18% in value.

Industrial diamond imports increased 14% in value. Exports plus reexports of industrial diamond increased 18% in caratage and 20% in value.

FOREIGN TRADE

Imports of abrasive materials reversed the decline that started in 1968 and were 20% more in value than in 1971. Exports plus reexports also increased. Net imports, the excess of imports over exports and reexports, were $15.5 million, a 132% increase over 1971 net imports. The domestic manufacture of synthetic diamond and export trade in other industrial diamond had an important influence on the value of exports.

[1] Physical scientist, Division of Nonmetallic Minerals.

Table 1.—Salient abrasive statistics in the United States

Kind	1968	1969	1970	1971	1972
Natural abrasives (domestic) sold or used by producers:					
Tripoli ... short tons	85,534	84,673	68,105	75,134	87,864
Value ... thousands	$796	$734	$520	$569	$797
Special silica-stone products [1] ... short tons	3,141	3,311	3,134	2,349	3,241
Value ... thousands	$629	$600	$665	$563	$670
Garnet ... short tons	22,136	20,458	18,837	18,984	18,916
Value ... thousands	$1,922	$1,874	$1,936	$1,934	$1,957
Emery ... short tons	W	W	W	1,586	2,883
Value ... thousands	W	W	W	W	W
Artificial abrasives [2] ... short tons	567,814	608,622	561,107	472,299	584,680
Value ... thousands	$86,316	$92,589	$85,772	$79,027	$92,958
Foreign trade (natural and artificial abrasives):					
Exports (value) ... do	$60,266	$70,687	$64,338	$60,685	$64,219
Reexports (value) ... do	$19,807	$20,373	$28,085	$21,711	$26,746
Imports for consumption (value) ... do	$103,150	$100,748	$96,467	$89,085	$106,512

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).

Table 2.—U.S. exports of abrasive materials, by kind

(Thousands)

Kind	1971 Quantity	1971 Value	1972 Quantity	1972 Value
NATURAL ABRASIVES				
Dust and powder of natural and synthetic precious or semi-precious stones, including diamond dust and powder..carats..	7,506	$18,726	8,263	$21,986
Crushing bort, except dust and powder..do....	20	94	55	305
Industrial diamond..do....	415	1,831	484	1,899
Emery, natural corundum, and other natural abrasives, n.e.c pounds..	20,888	2,368	21,850	2,797
MANUFACTURED ABRASIVES				
Artificial corundum (fused aluminum oxide)..do....	31,655	6,792	36,386	7,251
Silicon carbide, crude or in grains..do....	13,592	2,414	10,014	2,194
Carbide abrasives, n.e.c..do....	2,733	6,624	1,963	4,157
Grinding and polishing wheels and stones:				
Diamond..carats..	526	2,932	554	3,073
Pulpstones..pounds..	2,520	740	2,185	702
Polishing stones, whetstones, oilstones, hones, and similar stones..do....	640	901	873	981
Wheels and stones, n.e.c..do....	4,576	8,058	4,361	8,238
Abrasive paper and cloth, coated with natural or artificial abrasive materials..reams..	281	7,058	322	8,240
Coated abrasives, n.e.c..	NA	2,147	NA	2,396
Total..	XX	60,685	XX	64,219

NA Not available. XX Not applicable.

Table 3.—U.S. reexports of abrasive materials, by kind

(Thousands)

Kind	1971 Quantity	1971 Value	1972 Quantity	1972 Value
NATURAL ABRASIVES				
Dust and powder of natural and synthetic precious or semi-precious stones, including diamond dust and powder..carats..	392	$1,038	336	$790
Crushing bort except dust and powder..do....	348	2,181	329	1,925
Industrial diamond..do....	2,610	18,361	3,852	23,867
Emery, natural corundum, and other natural abrasives, n.e.c pounds..	244	59	295	60
MANUFACTURED ABRASIVES				
Grinding and polishing wheels and stones:				
Diamond..carats..	4	39	1	10
Wheels and stones, n.e.c..pounds..	6	7	35	40
Abrasive paper and cloth, coated with natural or artificial abrasive materials..reams..	1	3	5	37
Coated abrasives, n.e.c..	NA	23	NA	17
Total..	XX	21,711	XX	26,746

NA Not available. XX Not applicable.

Table 4.—U.S. imports for consumption of abrasive materials (natural and artificial), by kind

(Thousands)

Kind	1971 Quantity	1971 Value	1972 Quantity	1972 Value
Corundum, crude short tons	--	--	(1)	$2
Emery, flint, rottenstone, and tripoli, crude or crushed do	8	$276	4	222
Silicon carbide, crude do	99	13,958	105	15,053
Aluminum oxide, crude do	126	18,166	173	22,308
Other crude artificial abrasives do	1	133	(1)	107
Abrasives, ground, grains, pulverized or refined:				
Silicon carbide do	2	635	2	906
Aluminum oxide do	5	1,440	7	2,154
Emery, corundum, flint, garnet, and other, including artificial abrasives do	(1)	52	1	188
Papers, cloths, and other materials wholly or partly coated with natural or artificial abrasives	(2)	6,191	(2)	9,944
Hones, whetstones, oilstones, and polishing stones number	407	86	380	109
Abrasive wheels and millstones:				
Burrstones, manufactured or bound up into millstones short tons	4	(1)	(1)	11
Solid natural stone wheels number	(1)	3	1	10
Diamond do	59	371	53	562
Other	(2)	1,136	(2)	1,789
Articles not especially provided for:				
Emery or garnet	(2)	19	(2)	24
Natural corundum or artificial abrasive materials	(2)	206	(2)	183
Other	(2)	154	(2)	133
Diamond:				
Diamond dies number	12	236	9	188
Crushing bort carats	299	777	590	1,385
Other industrial diamond do	3,972	23,472	4,506	27,343
Miners' diamond do	913	4,653	1,024	4,712
Dust and powder do	7,726	17,121	9,014	19,179
Total	XX	89,085	XX	106,512

XX Not applicable.
[1] Less than ½ unit.
[2] Quantity not reported.

TRIPOLI

Although they differ in some respects, fine-grained, porous, silica materials are discussed as a group because they have similar properties and end uses. They include tripoli from Arkansas, Missouri, and Oklahoma; amorphous or soft silica from Illinois; and rottenstone from Pennsylvania. Production of crude tripoli (table 1) increased 17% in quantity and 40% in value. Finished material (table 5) for abrasive use was 63% of the total and material for filler use was 35%, compared with 67% and 31%, respectively, in 1971.

Tripoli producers in 1972 were Malvern Minerals Co., Garland County, Ark., and The Carborundum Co., Newton County, Mo., and Ottawa County, Okla. The major use for tripoli was for abrasive applications; it was also used as a filler. Amorphous silica producers were Illinois Min-

Table 5.—Processed tripoli [1] sold or used by producers in the United States, by use [2]

Use	1967	1968	1969	1970	1971	1972
Abrasives short tons	44,961	52,837	50,337	41,703	44,899	47,321
Value thousands	$1,916	$2,201	$2,013	$1,583	$1,692	$1,918
Filler short tons	11,240	13,418	14,352	18,093	20,457	25,973
Value thousands	$354	$388	$413	$545	$681	$847
Other short tons	4,797	5,203	5,487	1,134	1,327	1,584
Value thousands	$143	$149	$157	$28	$32	$43
Total short tons	60,998	71,458	70,176	60,930	66,683	74,878
Value [3] thousands	$2,413	$2,737	$2,584	$2,156	$2,406	$2,807

[1] Includes amorphous silica and Pennsylvania rottenstone.
[2] Partly estimated.
[3] Data may not add to totals shown because of independent rounding.

erals Co. and Tammsco, Inc., both in Alexander County, Ill. Rottenstone producers were Keystone Filler & Manufacturing Co. and Penn Paint & Filler Co., both in Lycoming County, Pa. Amorphous silica and rottenstone were also used for abrasives and fillers.

Hercules Minerals Corp., Pike County, Ark., a former tripoli producer, ceased operations in June. Penn Paint & Filler Co., Lycoming County, Pa. operated until June when Hurricane Agnes so badly damaged all installations that the company ceased operations.

Prices quoted in Engineering and Mining Journal, December 1972, for tripoli and amorphous silica were as follows:

Tripoli, paper bags, carload lots, f.o.b., cents per pound:

White, Elco, Ill.: Air floated through 200 mesh	1.30
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., dollars per ton:	
Illinois:	
Through 200 mesh, 90 to 95 percent	26
Through 200 mesh, 96 to 99 percent	27
Through 325 mesh, 90 to 95 percent	29
Through 325 mesh, 96 to 98 percent	30.50
Through 325 mesh, 98 to 99.4 percent	31.50
Through 325 mesh, 99.5 percent	45
Through 400 mesh, 99.9 percent	65
Below 15 microns, 99 percent	72
Below 10 microns, 99 percent	92
Dierks, Ark.:	
200 mesh	28
325 mesh	33

SPECIAL SILICA STONE PRODUCTS

Special silica stone products included the following: oilstones from Arkansas, whetstones from Indiana, grindstones from Ohio, grinding pebbles and deburring media from Minnesota and Wisconsin, and tube-mill liners from Minnesota. Production increased 38% in quantity and 19% in value.

Novaculite for oilstones was produced by Arkansas Abrasives, Inc., Arkansas Oilstones Co., Inc., John O. Glassford, Cleve Milroy, M. V. Smith, Hiram A. Smith Whetstone Co., and Norton Pike Division of Norton Co., all from operations in Garland County, Ark. Hindostan Whetstone Co. produced whetstone in Orleans County, Ind. Cleveland Quarries Co. produced grindstones at its Amherst quarry, Amherst County, Ohio. Jasper Stone Co. produced both grinding pebbles and tube-mill liners from its quarry in Jasper County, Minn. 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 (thousands)
1968	3,141	$629
1969	3,311	600
1970	3,134	665
1971	2,349	563
1972	3,241	670

[1] Includes grinding pebbles, grindstones, oilstones, tube-mill liners, and whetstones.

NATURAL SILICATE ABRASIVES

Garnet.—Sales of domestic garnet were slightly less in quantity and slightly more in value. Producers finished their products by crushing, grinding, and screening to specified particle sizes and grits. There were four active producers—two in New York and two in Idaho. Barton Mines Corp., Warren County, N.Y., the largest producer, processed the garnet for use in coated abrasives, glass grinding and polishing, and metal lapping. Also in New York, Interpace Corp., Essex County, recovered garnet as a byproduct in the processing of wollastonite ore. Idaho Garnet Abrasive Co. and Emerald Creek Garnet Milling Co. produced

Table 7.—Abrasive garnet sold or used by producers in the United States

Year	Quantity (short tons)	Value (thousands)
1968	22,136	$1,922
1969	20,458	1,874
1970	18,837	1,936
1971	18,984	1,934
1972	18,916	1,957

garnet from placer deposits in Benewah County, Idaho. The latter three producers reported use of garnet for various purposes: sandblasting, water filtration, nonskid paints, and miscellaneous abrasive applications.

Prices for New York garnet, f.o.b. North Creek, N.Y., 2,000-pound release, in 330- to 370-pound containers, cents per pound, were as follows:

Untreated for manufacturing of coated abrasives:	
Grades 16 through 36	18
Grades 40 through 220	20
Grades 240 through 280	25
Grades 320 through 600	22
Untreated for technical grinding and lapping:	
Mesh sizes 20 to 240	17
Mesh sizes 280 to 360	23
Micron sizes 27 to 23	26
Micron sizes 20 to 8	30
Micron sizes 6 to 5	22
Micron sizes 4 to 2	39

Prices for Idaho garnet, f.o.b. Seattle, group sizes, were 5.5 to 9 cents per pound.

NATURAL ALUMINA ABRASIVES

Corundum.—Commercial production of abrasive-grade corundum was last reported in the United States in 1918. In recent years, except in 1971, all of the corundum used by domestic industry was imported from Southern Rhodesia, but this trade was halted by the imposition of sanctions in 1968 by the United Nations. A small quantity of crude corundum was imported from Kenya in 1971. Also in 1971, Bendix Abrasives Division, Westfield Facility, of Westfield, Mass., acquired 1,964 short tons of corundum in Government stockpiles after Congressional approval was granted. The Office of Emergency Preparedness in 1969 had dropped corundum from the list of strategic and critical materials for stockpiling.

Corundum was crushed and classified to obtain a commercial product in a number of specified particle size ranges. Its use was chiefly for the grinding and finishing of optical lenses.

Table 8.—Natural corundum: World production, by country

(Short tons)

Country [1]	1970	1971	1972 [p]
India	454	345	422
Kenya	66	[e] 70	[e] 70
Malagasy Republic	2	[r] 1	[e] 1
Malawi	(2)	(2)	NA
South Africa, Republic of	272	[r] 266	324
U.S.S.R.[e]	7,200	7,200	7,700
Total	7,994	[r] 7,882	8,517

[e] Estimate. [p] Preliminary. [r] Revised. NA Not Available.

[1] In addition to the countries listed, Southern Rhodesia may have continued to produce natural corundum at a significant level (several thousand tons annually), but available information is inadequate to make reliable estimates of output levels.

[2] Less than ½ unit.

Emery.—Domestic production of emery in 1972 was by two producers, De Luca Emery Mine, Inc., near Peekskill in Westchester County, N.Y., and Oregon Emery Co., near Sweethome in Linn County, Oreg. Data on value of production were withheld to avoid disclosing individual company confidential data. The quantity of production, 2,883 tons, was nearly double that of 1971. Emery use was mostly in aggregate for heavy-duty nonslip floors, pavements, and stair treads. A minor use was in coated abrasives and tumbling abrasives.

INDUSTRIAL DIAMOND

Domestic production of synthetic industrial diamond in 1972 was estimated to be 15 million carats, up 2 million carats from 1971. Secondary production comprising salvage from used diamond tools and from wet and dry diamond-containing wastes was estimated to be 3 million carats.

The Government stockpile inventory as of December 31, 1972, was up to the objectives of 23.7 million carats of crushing bort and 20.0 million carats of stones. The objective for small diamond dies was 25,000. Congressional approval was granted in August 1971 for the disposal of excesses. As of December 31, 1972, excesses amounted to 18.1 million carats of bort and 3.4 million carats of stones; 473 small diamond dies were excess.

Exports and reexports of industrial diamond dust and powder, which included synthetics, were 8.6 million carats valued at $22.8 million. Crushing bort, except dust and powder, exported amounted to 384,000 carats valued at $2.2 million. Exports of stones were 4.3 million carats valued at $25.8 million. The total of exports and reexports of dust and powder, bort, and stones increased from 11.3 million carats in 1971 to 13.3 million carats, and the value increased from $42.2 million to $50.8 million.

Imports of industrial diamond in 1972 increased 17% in number of carats and 14% in value from 1971. Shipments from Ireland were 7.5 million carats valued at $17.9 million, increases of 25% in quantity and 13% in value respectively in 1972 over the 1971 figures. The share of imports from Ireland was 49% of quantity and 34% of value.

Table 9.—U.S. imports for consumption of industrial diamond (excluding diamond dies)

(Thousand carats and thousand dollars)

Year	Quantity	Value
1970	13,365	49,037
1971	12,910	46,023
1972	15,134	52,619

WORLD REVIEW

Angola.—Diamond production from Angola's sole producer in 1971, Companhia de Diamantes de Angola (DIAMANG), was 2,413,000 carats. Exports were 2,340,087 carats in 1971 but the total earnings to Angola decreased because gem-quality diamond was less and world prices for gem diamond were depressed.. The average value per carat decreased 30%. In 1971 DIAMANG treated 4.14 million cubic meters of diamond-bearing material at an average grade of 0.58 carat per cubic meter. Plans by DIAMANG for 1972 were expected to yield the same production in carats but at a higher value because of increased world prices.

In 1972, the consortium formed by DIAMANG and De Beers Consolidated Mines Ltd. of Kimberley, Republic of South Africa, known as Consorcio Mineiro de Diamantes, was active in exploration and development. The consortium was allowed to prospect 500,000 square kilometers (km^2) in 1972, but its area will decrease to 30,000 km^2 by 1977. DIAMANG was assigned an area of 50,000 km^2.

Areas assigned to other concessionaires ranged in size from 25,700 km^2 to 5,286 km^2. By size of concession, the concessionaires were Companhia de Diamantes do Oeste de Angola, Companhia Nacional de Diamantes, Companhia Ultramarina de Diamantes, and Companhia Internacional de Exploração de Diamantes.

Australia.—No commercial quantities of diamond have been found in Australia to the present. However, in 1972 a kimberlitic eruption-type crater was located in northern New South Wales. Over A$500,000 was allocated to explore an area of 1,500 to 2,000 acres.[2]

Belgium.—The Antwerp Diamond Co. announced formation of a venture with Almazjuvelirexport of the U.S.S.R. for exclusive world sales rights for all Russian diamonds.

Botswana.—The Orapa diamond mine was officially opened on May 26, 1972, in a ceremony attended by the President of Botswana and the Chairman of the Board of De Beers. The mine actually went onstream in June 1971; the open pit operation processed 8,000 tons per day with an above-average caratage per ton. The value per ton processed is low because industrial diamonds are more than 50% by weight of the yield. The use of sophisticated concentrating equipment, which includes a heavy-media cyclone plant and X-ray separators, was claimed to effect a nearly 100 percent recovery of diamond.[3]

Canada.—The Ontario Department of Mines and Northern Affairs recommended further exploration for diamond based on the demonstrated favorable environment in Northern Ontario.[4]

Central African Republic.—The Government established a National Diamond Agency in March 1972 to organize all dia-

[2] Far Eastern Economic Review. V. 77, No. 29, July 15, 1972, pp. 43–44.

[3] Engineering and Mining Journal. V. 173, No. 8, August 1972, p. 32.

[4] Journal of Mines, Metals and Fuels. V. 20, No. 5, May 1972, p. 161.

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			
	1971		1972		1971		1972		1971		1972		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Australia	--	--	--	--	22	145	5	58	52	248	43	189	--	--	--	--
Belgium-Luxembourg	52	112	231	489	981	4,044	1,475	6,131	10	57	2	11	431	798	110	192
British West Africa	11	26	--	--	53	161	14	74	(1)	(1)	2	11	24	51	--	--
Canada	9	41	--	--	51	168	38	137	21	72	7	26	283	343	319	311
Central African Republic	8	17	--	--	52	260	6	195	--	--	--	--	--	--	--	--
Congo (Brazzaville)	--	--	--	--	20	118	42	123	1	5	--	--	8	21	--	--
France	--	--	--	--	(1)	1	8	310	2	22	--	--	1	2	2	3
Germany, West	--	--	--	--	5	29	5	45	--	--	--	--	4	9	30	56
Ghana	--	--	2	7	97	545	76	380	1	6	6	30	7	13	10	5
Hong Kong	--	--	--	--	7	204	1	47	--	--	--	--	--	--	--	--
Ireland	6	16	--	--	13	40	14	34	722	3,747	583	2,739	5,277	12,087	6,869	15,155
Israel	35	104	--	--	13	307	16	320	(1)	12	2	7	8	17	8	17
Japan	11	41	--	--	109	2,025	111	2,162	16	27	1	2	549	1,208	808	1,685
Liberia	--	--	--	--	4	171	(1)	(1)	--	--	--	--	--	--	--	--
Netherlands	39	85	29	90	464	2,772	328	2,894	1	4	(1)	1	244	504	70	144
Sierre Leone	--	--	--	--	--	--	(1)	13	--	--	--	--	--	--	(1)	1
South Africa, Republic of	64	194	127	320	1,242	7,727	1,143	7,541	35	160	353	1,559	238	498	115	244
Switzerland	--	--	12	26	21	122	13	146	--	--	(1)	(1)	30	56	115	137
United Kingdom	--	--	88	225	635	3,400	1,040	5,717	13	60	14	58	577	1,406	345	816
U.S.S.R.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	116	183
Venezuela	(1)	(1)	4	9	66	753	2	35	29	180	8	64	--	--	--	--
Western Portuguese Africa, n.e.c.	--	--	--	--	8	94	85	719	--	--	--	--	--	--	--	--
Zaire	64	141	97	219	96	253	75	216	9	50	(1)	1	29	76	84	212
Other	--	--	--	--	13	133	9	46	1	3	3	14	16	32	13	18
Total	299	777	590	1,385	3,972	23,472	4,506	27,343	913	4,653	1,024	4,712	7,726	17,121	9,014	19,179

[1] Less than ½ unit.

Table 11.—Diamond (natural): World production by country [1]

(Thousand carats)

Country	1970 Gem	1970 Industrial	1970 Total	1971 Gem	1971 Industrial	1971 Total	1972 p Gem	1972 p Industrial	1972 p Total
Africa:									
Angola	1,797	599	2,396	1,810	603	2,413	1,171	391	1,562
Botswana	r 47	r 417	r 464	82	740	822	360	2,043	2,403
Central African Republic	313	169	482	288	149	437	346	178	524
Ghana	255	2,295	2,550	256	2,306	2,562	266	2,393	2,659
Guinea e	22	52	[2] 74	22	52	74	25	55	80
Ivory Coast	85	128	213	130	196	326	131	199	e 330
Lesotho [3]	4	13	17	1	6	7	1	8	9
Liberia	[4] 577	[4] 235	[4] 812	[4] 532	[4] 277	[4] 809	532	278	e 810
Sierra Leone [5]	723	1,232	1,955	715	1,220	1,935	609	1,038	1,647
South Africa, Republic of:									
Premier mine	623	1,867	2,490	609	1,828	2,437	613	1,841	2,454
Other De Beers Company [6]	2,615	2,140	4,755	2,162	1,769	3,931	2,291	1,874	4,165
Other	520	347	867	398	265	663	466	310	776
Total	3,758	4,354	8,112	3,169	3,862	7,031	3,370	4,025	7,395
South-West Africa, Territory of	1,772	93	1,865	1,566	82	1,648	1,516	80	1,596
Tanzania	359	349	708	419	418	837	365	365	[5] 730
Zaire	1,649	12,438	14,087	1,250	11,270	12,520	980	12,380	13,360
Other areas:									
Brazil e	r 150	r 150	r 300	r 150	r 150	r 300	155	155	310
Guyana	24	37	61	19	29	48	20	29	49
India	17	3	20	16	3	19	17	3	20
Indonesia e	14	6	20	12	3	15	12	3	15
U.S.S.R. e	1,600	6,250	7,850	1,800	7,000	8,800	1,850	7,350	9,200
Venezuela	r 131	r 378	r 509	114	385	499	141	315	456
World total	13,297	29,198	42,495	12,351	28,751	41,102	11,867	31,288	43,155

e Estimate. p Preliminary. r Revised.

[1] Total (gem plus industrial) diamond output of 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 represent Bureau of Mines estimates in the case of all countries except Lesotho (all years), Liberia (1970 and 1971) 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] Official estimate by Government of Guinea.

[3] Exports of diamond originating in Lesotho; excludes stones imported for cutting and subsequently reexported.

[4] Exports for year ended August 31 of that stated.

[5] Exports

[6] All company output from the Republic of South Africa except for that from the Premier mines; also excludes company output from the Territory of South-West Africa and from Botswana.

mond activities to the benefit of the Central African Republic.

Ghana.—In June 1972, the Government notified foreign mining companies of its intent to obtain a majority control of all mining ventures. The Consolidated African Selection Trust diamond mine at Akwatia was affected by the decree.

India.—All production of diamond in India came from the Panna District of Madhya Pradesh State, under the direct control and supervision of the Government-owned National Mineral Development Corp. The 1972 output was 19,747 carats estimated to be 82% gem diamond and 18% industrial. To sustain the indigenous diamond industry, India imported both gem and industrial diamond.

Lesotho.—The Lesotho Department of Mines and Geology reported the value of diamond exports declined 8% in 1972 from that of 1971.[5] London and Rhodesian Mining and Land Co. ceased prospecting operations at Kao in Butha Buthe district, which it had began in 1969 after spending $1.25 million in prospecting. Rio Tinto-Zinc Corp pulled out of Letseng-La-Terai in the Mokhotlong district after spending $3.75 million on prospecting. Newmont Mining

[5] Mineral Trade Notes. V. 70, No. 3, March 1973, pp. 3–4.

Corp. began prospecting at Kao in late 1971, and its expenses to the end of 1972 were $1.9 million.

The Government of Lesotho and the Embassy of the United States in Lesotho announced approval of a request to include Lesotho in an electronic photo survey by a U.S. Earth Resources Technology Satellite to be launched by the U.S. National Aeronautics and Space Administration. The satellite imagery will be supplemented by ground research of favorable areas for diamond deposits by the Lesotho Department of Mines and Geology.

Sierra Leone.—The third largest diamond ever found, "Star of Sierra Leone," 968.9 carats, was removed from the vibrating grease belt in the separator plant of The National Diamond Mining Co., Ltd. (DIMINCO) mine at Yengema on February 14, 1972.[6] DIMINCO operated at full capacity on its lease, which is in an alluvial area similar to that of many concessions operated by thousands of unincorporated diggers. The life of the alluvial diggings was estimated to be 3 to 5 years. Hence, DIMINCO conducted prospecting by drilling in its lease area for kimberlite. Diamond exports accounted for more than 60% of the value of exports from Sierra Leone. If the life of the alluvial diggings is as short as indicated, a vast change in the country's economy will occur.[7]

South Africa, Republic of.—Over 40% of the gem quality diamond output of the world in the last 5 years was credited to South Africa and South West Africa combined.[8] The combined total was 20% of the total world natural diamond production —both gem and industrial. The DeBeers group produced 90% of the area output.

U.S.S.R.—Synthetic diamonds were introduced to industry in the U.S.S.R. about 1962. Currently out of every 100 carats of diamond used in Soviet industry, 85 carats are synthetic.[9] Natural diamond mined in Siberia is equal in production to that of South Africa, according to a representative of V-O Almazjuvelirexport, the U.S.S.R. foreign trade organization at a trade fair in Seattle.[10]

Zaire.—Zaire maintained its position as the world's leading source of industrial diamond. Production was limited because of competition from synthetic diamond.[11]

TECHNOLOGY

A claim was made that the U.S.S.R. state standards were the first in the world for the strength of grains of polishing powders, for abrasive capacity, and for surface roughness of the finished work. These standards, U.S.S.R. GOST 9206–70, applied to synthetic diamond powders.[12] The Industrial Diamond Association of India in cooperation with the De Beers Industrial Diamond Division of the United Kingdom held a seminar, December 4–5, 1972, which included a number of foreign expert speakers. A claim for the U.S.S.R. was that synthetic diamond of ballas and carbonado type have been created. The claim was also made that "slavutich," a superhard material which is a formed or shaped sintered synthetic material, may be substituted for natural diamond stones.

In the United States, it was claimed that sintered polycrystalline diamond can be preshaped to any form. . . . "points, wedges, plates, pierced parts and rollers . . . up to 20 carats."[13] In some applications, cubic boron nitride proved superior to diamond.[14] Scientists at the General Electric Research and Development Center reported the development of cutting tool inserts fabricated from synthetic diamond and cubic boron nitride into polycrystalline compacts backed by cemented tungsten carbide.[15]

An international file of abstracts relative to properties of diamond, hard materials, machines, and patents was published monthly.[16]

---

[6] Canadian Mining and Metallurgical Bulletin. Star of Sierra Leone. V. 65, No. 725, September 1972, p. 57.

[7] Meisler S. Diamond Digging in Sierra Leone Is Dirty Business. Denver Post, Sept. 28, 1972, p. 47.

[8] Engineering and Mining Journal. Diamonds: One of South Africa's Best Friends. V. 173, No. 11, November 1972, pp. 184–185.

[9] Soviet Export. Synthetic Diamonds Spur Technological Progress. V. 16. 4(70), 1972, pp. 2–15.

[10] Barnett, C. Soviet Diamonds Mined in Siberia Dazzle Onlookers at Trade Fair. J. of Commerce, v. 313, No. 22,762, Aug. 15, 1972, p. 3.

[11] Putnam, J. J. Yesterday's Congo, Today's Zaire. National Geographic, v. 143, No. 3, March 1973, p. 408.

[12] Chernyakhovsky, Y. A., and I. Y. Roshkov. Synthetic Diamonds Spur Technological Progress. Soviet Export, No. 16. 4(70), 1972, p. 5.

[13] American Metal Market. Industrial Diamond Association Discusses Broad Capabilities of New Shaped Tools. v. 79, No. 74, Apr. 17, 1972, p. 16.

[14] Work cited in footnote 13.

[15] Engineering and Mining Journal. E.M.J. Outlook. V. 173, No. 12, December 1972, p. 19.

[16] Industrial Diamond Review. Published monthly, January to December 1972, 538 pages inclusive. Each monthly issue contained from 10 to 15 pages of abstracts and patent information.

ARTIFICIAL ABRASIVES

Crude fused aluminum oxide was produced in 1972 by five firms in the United States and Canada. The Carborundum Co., Norton Co., and General Abrasive Co., Inc., each operated plants in both countries. The Exolon Co. and Simonds Canada Abrasive Co., Ltd., operated plants in Canada. Output of white, high-purity material was 24,485 tons and of regular grade was 159,843 tons. Thirteen percent of the combined output of white and regular was used for nonabrasive applications, principally in the manufacture of refractories. Output was 63% of rated plant capacity.

Silicon carbide was produced in 1972 by six firms in the United States and Canada. The Carborundum Co. operated plants in both countries and Electro-Refractories & Abrasives, Ltd., The Exolon Co., Norton Co., and General Abrasive Co., Inc., operated in Canada; all produced crude for abrasive, refractory, and miscellaneous uses. Satellite Alloy Corp. operated in the United States and produced crude for refractories and other nonabrasive applications. Production was 85% of capacity and consumption was 57% for abrasive use and 43% for refractory and other nonabrasive applications.

The manufacture of metallic abrasives in 1972 increased 17% in quantity and 19% in value. Of the total quantity sold or used, steel shot and grit was 75%; chilled iron shot and grit, 16%; annealed iron shot and grit, 9%. Other metallic abrasives sold or used in small quantities included aluminum, copper, and zinc, and metallic oxides and carbides. Production from Ohio was 30% of the total quantity, the highest of the producing states. Michigan, Pennsylvania, and Indiana followed in rank of quantity and their combined output was 62% of the total. The remaining 8% was produced by Alabama, New York, and Connecticut. Industrial Corp. of Pittsburgh, Pa., recycled metallic abrasives for other producers and consumers.

Producers of metallic abrasives were as follows:

Company	Plants
Abbott Ball Co	Hartford, Conn.
Abrasive Materials, Inc	Hillsdale, Mich.
Abrasive Metals Co	Pittsburgh, Pa.
The Carborundum Co	Butler, Pa.
Cleveland Metal Abrasive Co	Birmingham, Ala.
	Howell, Mich.
	Springville, N.Y.
	Cleveland, Ohio
	Toledo, Ohio
Durasteel Co	Pittsburgh, Pa.
Ervin Industries	Adrian, Mich.
Globe Steel Abrasive Co	Mansfield, Ohio
Metal Blast, Inc	Cleveland, Ohio
National Metal Abrasive Co	Do.
Pellets, Inc	Tonowanda, N.Y.
Steel Abrasives, Inc	Hamilton, Ohio
Wheelabrator-Frye, Inc	Mishawaka, Ind.

TECHNOLOGY

Silicon carbide was produced from waste rice hulls and iron oxide in a process developed at the University of Utah by Dr. Ivan B. Cutler and associates.[17] The silicon carbide from the process was finely crystalline.

Zirconia alumina abrasive was used in coated abrasives for the first time and was claimed to have greater life and faster cut than any other abrasive.[18]

The number of patents describing abrasive materials used in abrasive and refractory products was large, but most of the

[17] Chemical and Engineering News. Concentrates Technology. V. 50, No. 38, Sept. 18, 1972, p. 13.
[18] Abrasive Engineering. Breakthrough for Coated Abrasives. V. 18, No. 5, September/October 1972, pp. 24–25.

Table 12.—Crude artificial abrasive produced in the United States and Canada

(Thousand short tons and thousand dollars)

Kind	1968	1969	1970	1971	1972
Silicon carbide [1]	159	161	167	130	166
Value	$23,833	$23,945	$24,038	$21,123	$24,690
Aluminum oxide (abrasive grade)[1]	192	217	195	149	184
Value	$27,705	$31,276	$27,402	$24,514	$28,590
Metallic abrasives [2]	216	230	199	193	235
Value	$34,778	$37,369	$34,332	$33,390	$39,678
Total [3]	568	609	561	472	585
Value [3]	$86,316	$92,589	$85,772	$79,027	$92,958

[1] Figures include material used for refractories and other nonabrasive purposes.
[2] Shipments for U.S. plants only.
[3] Data may not add to total shown because of independent rounding.

Table 13.—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)	
1971:					
Chilled iron shot and grit	26,514	$3,035	25,965	$3,323	204,375
Annealed iron shot and grit	20,143	2,324	19,373	2,750	[2] 139,843
Steel shot and grit	145,444	21,651	146,330	26,876	207,163
Other [3]	1,778	298	1,769	441	8,500
Total	193,879	27,308	193,437	33,390	420,038
1972:					
Chilled iron shot and grit	31,531	4,048	37,300	4,679	129,000
Annealed iron shot and grit	18,615	2,110	20,868	2,713	(2)
Steel shot and grit	175,938	25,860	175,799	31,844	228,650
Other [3]	766	356	833	442	4,500
Total	226,850	32,374	234,800	39,678	362,150

[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.

patents described improvements in the materials and the machines that use these materials. Articles in trade journals and magazines were plentiful in the description of new processes, new products, and new applications.

Table 14.—Stocks of crude artificial abrasives and capacity of manufacturing plants in the United States and Canada

(Thousand short tons)

Year	Silicon carbide		Aluminum oxide	
	Stocks Dec. 31	Annual capacity	Stocks Dec. 31	Annual capacity
1968	17.7	179.7	25.5	357.2
1969	9.1	181.7	33.2	358.2
1970	18.7	179.1	30.8	359.2
1971	14.2	198.1	25.6	293.2
1972	5.2	195.7	16.3	291.2

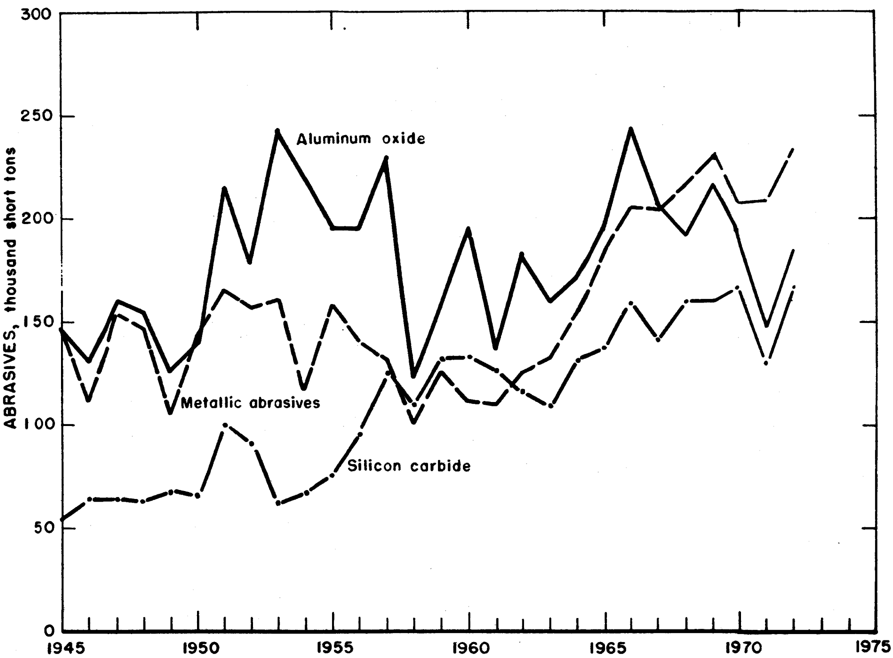

Figure 1.—Artificial abrasives production.

Aluminum

By John W. Stamper [1]

Consumption of aluminum in the United States increased dramatically, and the industry's oversupply problem, which was at its worst in 1970 and 1971, appeared to be ended. Production facilities that had been closed during 1970–71 were reopened, and the operating rate was increased markedly, although output increased at a slower rate than demand.

World demand also increased significantly, and the oversupply of the past few years in most countries was eased somewhat. World output increased 6.4%, compared with an estimated 10% increase in demand. The largest production increase was in Asia, where Japan produced about 14% more than in 1971. The world operating rate was 85% of yearend capacity, compared with an 83% rate during 1971.

Table 1.—Salient aluminum statistics

(Thousand short tons and thousand dollars)

	1968	1969	1970	1971	1972
United States:					
Primary production	3,255	3,793	3,976	3,925	4,122
Value	1,639,621	2,013,403	2,190,087	2,154,446	2,069,555
Price: Ingot, average cents per pound	25.6	27.2	28.7	29.0	25.0
Secondary recovery	817	901	781	816	946
Exports (crude and semicrude)	351	575	612	293	329
Imports for consumption (crude and semicrude)	793	558	468	690	794
Consumption, apparent	4,663	4,710	4,519	5,099	5,588
World: Production	8,839	9,885	10,641	11,375	12,103

Legislation and Government Programs.—During 1972, 6,125 short tons of primary aluminum was sold from Government inventories under the long-range disposal contracts between industry and the General Services Administration that were implemented in December 1965. The total quantity sold under the program from December 1965 through December 1972 was 623,498 short tons.

Contracts between the Government and aluminum producers, covering industry purchases of surplus aluminum metal from U.S. stockpiles, were amended in December to provide for the sale of 120,000 tons of metal per year during the 3-year period beginning July 1, 1972. Annual industry purchases under the amended contracts after July 1, 1975, were scheduled to decline over the years through 1990. The aluminum stockpile objective of 450,000 tons was reduced to zero on December 20, 1972, and the sales could include the entire quantity of aluminum held in Government inventories which totaled about 1,263,000 tons.

The Bureau of Domestic Commerce (BDC), U.S. Department of Commerce, established aluminum set-asides each quarter during 1972 to meet the estimated requirements of the Department of Defense, Atomic Energy Commission, National Aeronautics and Space Administration, and related defense programs. The set-aside for the year was 250,000 short tons, down from 315,000 tons in 1971 and 455,000 tons in 1970.

The Bureau of Customs received information from a domestic firm on April 7, 1972, indicating a possibility that alumi-

[1] Physical scientist, Division of Nonferrous Metals.

num ingot from Canada was being sold, or was likely to be sold, in the United States at less than fair value within the meaning of the Antidumping Act of 1921, as amended. Having conducted a summary investigation as required and having determined that there were grounds for so doing, the Bureau of Customs instituted an inquiry to verify the information submitted and to obtain the facts necessary to enable the Secretary of the Treasury to reach a determination as to the fact or likelihood of sales at less than fair value. The Bureau of Customs concluded that the information received tended to indicate that the prices of aluminum ingot sold for exportation to the United States from Canada were less than the prices of sales for consumption in Canada. At yearend, the matter was still under study by the Department of the Treasury.

DOMESTIC PRODUCTION

Primary.—Some aluminum production facilities that had been shut down during the 1970–71 period of oversupply were reopened in 1972 and primary output increased by 5%.

Annual capacity at the Alcoa, Tenn., plant of the Aluminum Company of America (Alcoa) was increased by 70,000 tons, and capacity at the Hannibal, Ohio, plant of Ormet Corp. was raised 10,000 tons per year. The operating rate of the industry based on the entire year was 86.9% of yearend capacity, compared with an 84.2% rate in 1971. The rate of production in December 1972 was 90.4% of yearend capacity, compared with a rate of 81.9 during December 1971 on the same basis.

Electric energy supply was curtailed in the Pacific Northwest during the latter part of the year, owing to low water conditions, delays in starting up new hydro facilities and a coal-fired steam electric generating plant at Centralia, Wash., and a temporary shutdown, for refueling, of the nuclear powerplant at Hanford, Wash. The Bonneville Power Administration (BPA) announced that it would raise its power rates to the aluminum industry by 25% in December 1974 and probably by another 25% in 1979. Power rates to the aluminum industry in the Pacific Northwest, which is served by BPA, were believed to average about 2.5 mills per kilowatt-hour in 1972.

Alcoa restarted several of its potlines that had been closed during 1970–71 and began modernizing its Massena, N.Y., primary aluminum plant, replacing three potlines that were built during World War II. The company continued to plan construction of a magnesium plant at Addy, Wash., which was scheduled for completion in 1975. Most of the magnesium output of the plant, as well as coproduct silicon metal, was expected to be used by Alcoa in aluminum alloys. In 1972, only Reynolds Metals Co. (Reynolds) had captive silicon production facilities (at Listerhill, Ala.). Other primary producers as well as secondary smelters purchased silicon requirements.

The worlds largest rolling mill, capable of reducing aluminum ingots to finished plate 18 feet wide (4 feet wider than previously available), was officially opened by Alcoa at Davenport, Iowa. Finished aluminum plate up to 8 inches in thickness or tapered aluminum plate of extreme widths reportedly can be produced at the mill. The company established a Technology Marketing Division to coordinate and market its

Table 2.—Production and shipments of primary aluminum in the United States

(Short tons)

Quarter	1971 Production	1971 Shipments	1972 Production	1972 Shipments
First	974,951	973,036	975,842	1,000,381
Second	993,853	1,020,896	1,017,181	1,052,884
Third	988,669	965,082	1,044,857	1,032,915
Fourth	967,750	928,415	1,084,571	1,091,010
Total	3,925,223	3,887,429	4,122,451	4,177,190

proprietary processing, engineering, and aluminum plant construction capabilities. Alcoa planned to expand its aluminum metal powder production operations to include fabrication of powdered products with the purchase of the assets of the Powdered Metal Division of the Barden Corp. at North Haven, Conn.

Alcoa announced that it was developing a new primary aluminum production process that was 30% more efficient than the presently used Hall process (see Technology). The new process was scheduled to be tested on a semicommercial scale in a 15,000-ton-pilot-plant in 1975. The company also purchased, near Laramie, Wyo., a large deposit of anorthosite, one of several alternatives to bauxite as a source of aluminum.

American Metal Climax, Inc. (AMAX), reportedly deferred plans to begin construction of a 75,000-ton-per-year aluminum plant between Guyana and Aguirre on the south coast of Puerto Rico. How-

Table 3.—Primary aluminum production capacity in the United States, by company

(Thousand short tons)

Company and plant	Capacity at yearend 1971	Capacity at yearend 1972	Ownership
Aluminum Co. of America (Alcoa):			Self, 100%.
Alcoa, Tenn	200	270	
Badin, N.C	115	115	
Evansville (Warrick), Ind	275	275	
Massena, N.Y	130	130	
Point Comfort, Tex	185	185	
Rockdale, Tex	280	280	
Vancouver, Wash	115	115	
Wenatchee, Wash	175	175	
Total	1,475	1,545	
Anaconda Aluminum Co.: Columbia Falls, Mont	180	180	Self, 100%.
Consolidated Aluminum Corp. (Conalco):			Swiss Aluminium Ltd., 60%; Phelps Dodge Corp., 40%.
Lake Charles, La	35	35	
New Johnsonville, Tenn	140	140	
Total	175	175	
Eastalco Aluminum Co.: Frederick, Md	87	87	Howmet Corp., 100%.
Martin Marietta Aluminum, Inc.:			Martin Marietta Corp., 87.2%.
The Dalles, Oreg	90	90	
Goldendale, Wash	110	110	
Total	200	200	
Intalco Aluminum Corp.: Ferndale (Bellingham), Wash	260	260	American Metal Climax, Inc., 50%; Howmet Corp., 50%.
Kaiser Aluminum & Chemical Corp.:			Self, 100%.
Chalmette, La	260	260	
Mead, Wash	206	206	
Ravenswood, W. Va	163	163	
Tacoma, Wash	81	81	
Total	710	710	
National-Southwire Aluminum Co.: Hawesville, Ky	180	180	National Steel Corp., 50%; Southwire Co., 50%.
Noranda Aluminum Inc.: New Madrid, Mo	70	70	Noranda Mines, Ltd., 100%.
Ormet Corp.: Hannibal, Ohio	240	250	Olin Corp., 50%; Revere Copper & Brass, Inc., 50%.
Revere Copper & Brass, Inc.: Scottsboro, Ala	112	112	Self, 100%.
Reynolds Metals Co.:			Self, 100%.
Arkadelphia, Ark	63	63	
Corpus Christi (San Patricio), Tex	111	111	
Jones Mills, Ark	122	122	
Listerhill (Sheffield), Ala	221	221	
Longview, Wash	200	200	
Massena, N.Y	128	128	
Troutdale, Oreg	130	130	
Total	975	975	
Total United States	4,664	4,744	

ever, the company reportedly concluded a long-term agreement with Alcoa for the purchase of 440,000 short tons of alumina per year from Australia. AMAX had been purchasing about 250,000 tons per year from Alcoa for reduction to aluminum metal at the Ferndale, Wash., aluminum plant, operated by Intalco Aluminum Corp. The corporate structure and operations of the aluminum group of AMAX were described in a report.[2]

Construction of The Anaconda Company alumina reduction plant at Sebree, Ky., continued, with initial production from the 120,000-ton-per-year facility scheduled for the second quarter of 1973. The company also announced an agreement, in principle, to purchase the Russell Aluminum Corp., an important fabricator of finished and semifinished aluminum products.[3]

Kaiser Aluminum & Chemical Corp. reactivated potlines at Chalmette, La., and Ravenswood, W. Va. Total capacity of the lines, which had been closed during 1970 and 1971 owing to market conditions, was about 70,000 tons per year. The company indicated that it would accelerate its $15 million pollution control program at Mead, Wash., and asked permission to reopen two lines at that location with a production equivalent of 52,000 tons of aluminum per year.

National-Southwire Aluminum Co., a primary aluminum producer, and Colorado Central Mines, Inc., announced a joint venture to investigate the use of alunite instead of bauxite as a source of aluminum metal. A pilot plant was being constructed near Golden Colo., to test the alunite from a deposit in Utah controlled by the two firms. Olin Corp., a diversified chemical, paper, and metal producer, announced that it planned to dispose of its aluminum operations. The company indicated that the proposed sale included its 50% share of the primary aluminum production and rolling facilities at Hannibal, Ohio, operated by the Ormet Corp., and seven separate fabricating plants (four extrusion operations, two conductor plants, and an architectural products plant) around the country. Olin's 40% equity in Compagnie International pour la Production de l'Alumine (FRIA), a bauxite and alumina producer in the Republic of Guinea, and its Metals Research Laboratories in New Haven, Conn., were not included.

2 Engineering & Mining Journal. AMAX. V. 173, No. 9, September 1972, pp. 146–152.
3 American Metal Market. Chile Copper Curbs Speed Anaconda Aluminum Push. V. 79, No. 147, Aug. 11, 1972, p. 2.

Table 4.—Aluminum recovered from scrap processed in the United States, by kind of scrap and form of recovery

(Short tons)

Kind of scrap	1971	1972 p
New scrap:		
Aluminum-base	[1] 648,138	[2] 755,762
Copper-base	83	99
Zinc-base	97	118
Magnesium-base	r 298	376
Total	648,616	756,355
Old scrap:		
Aluminum-base	[1] 167,030	[2] 188,594
Copper-base	50	51
Zinc-base	621	636
Magnesium-base	66	91
Total	167,767	189,372
Grand total	816,383	945,727

Form of recovery	1971	1972 p
As metal	85,265	79,535
Aluminum alloys	720,403	849,778
In brass and bronze	469	1,068
In zinc-base alloys	4,134	8,073
In magnesium alloys	881	2,042
In chemical compounds	5,231	5,231
Total	816,383	945,727

p Preliminary.
r Revised.
1 Aluminum alloys recovered from aluminum-base scrap in 1971, including all constituents, were 680,746 tons from new scrap and 189,412 tons from old scrap and sweated pig, a total of 870,158 tons.
2 Aluminum alloys recovered from aluminum-base scrap in 1972, including all constituents, were 795,649 tons from new scrap and 213,255 tons from old scrap and sweated pig, a total of 1,008,904 tons.

Reynolds Metals Co., which had reacted to the 1970–71 oversupply situation by shutting down a large percentage of its primary aluminum capacity, was quick to react to the increase in market demand and reopened potlines at Longview Wash., Listerhill, Ala., and Troutdale, Oreg.

Secondary.—Recovery of secondary aluminum, calculated from reports to the Bureau of Mines, was 945,727 short tons, 15.8% above the 1971 level. Calculated recovery of all metallic constituents from aluminum base scrap increased 15.9% to 1,008,904 tons.

The Bureau estimated that full coverage of the industry would indicate a total scrap consumption of 1,342,000 short tons in 1972. Using this estimate, aluminum recovery totaled 1,045,000 short tons in 1972 and metallic recovery was estimated at 1,126,000 tons.

Construction by 1973 of a new plant to recover aluminum and other materials from the residues of a municipal incinerator at Lowell, Mass., was announced by Raytheon Co. The plant, costing $3.2 million, is to be 75% financed by the Environmental Protection Agency (EPA) and will get some support from State and city governments. The new facility was expected to treat 65,000 tons of residue per year and recover 1,000 tons of aluminum, 700 tons of zinc and copper, and 13,500 tons of colorless glass annually.

The city of Baltimore reportedly will build a $14 million solid-waste disposal plant that was expected to pay for more than 80% of its operating costs by the sale of reclaimed material. This plant was to be designed by Monsanto Enviro-Chem Systems, Inc., a subsidiary of the Monsanto Co.

The aluminum beverage can recycling programs of major primary producers, several beverage producers, and others continued to gain momentum. Industry estimates indicated that the number of aluminum cans recycled rose rapidly, from about 10 million in 1968 to 1.4 billion in 1972. Assuming an average of 22 cans per pound, these estimates translate to 230 tons recylced in 1968 and 33,000 tons recycled in 1972. Over 1,000 centers for the collection of aluminum cans, worth 10 cents per pound, were said to be located in 39 States.

A comprehensive study of the availability of metal (including aluminum), prepared by the Battelle Memorial Institute for the National Association of Secondary Materials Industries and EPA, was briefly reviewed.[4] Of the 2,215,000 tons of old and new aluminum scrap estimated by Battelle to have been available for recycling in 1969, only 48% was recycled, mostly in the form of new scrap. Of the total quantity of scrap that was available in that year, 60% was in the form of old scrap, of which only 13% was recovered. Collection was cited as the major problem in improving recovery from old scrap. Aluminum used in containers and packaging represented the largest portion of the unrecovered old scrap. Aluminum used in transportation and in consumer durables also was difficult to recycle because of the collection problem.

Alloys & Chemical Corp., an important producer of secondary aluminum alloys from purchased aluminum base scrap, closed its Cleveland, Ohio plant late in the year. The company, a subsidiary of Rio Tinto Zinc Corp, Ltd. of London, indicated that the closing was necessary mainly because of depressed market prices and the

[4] Metals Week. Focus on Unrecovered Metals. V. 43, No. 13, Mar. 17, 1972, pp. 1–2.

Table 5.—Consumption of and recovery from purchased new and old aluminum scrap in 1972 [1]

(Short tons)

Class	Consumption	Calculated recovery	
		Aluminum	Metallic
Secondary smelters	706,484	549,044	594,336
Primary producers	205,231	185,056	194,078
Fabricators	124,647	112,062	116,491
Foundries	110,640	94,073	99,647
Chemical producers	5,231	4,121	4,352
Total	1,152,233	944,356	1,008,904
Estimated full industry coverage	1,342,000	1,045,000	1,126,000

[1] Excludes recovery from other than aluminum-base scrap.

lack of profits. The company's inability to invest in equipment to meet municipal standards for air pollution control also was cited as a factor.

Vulcan Materials Co. consolidated the operations of its secondary aluminum division with that of its metallics (detinning) division during the year. The new combined division will operate secondary aluminum facilities at Sandusky, Ohio, Milwaukee, Wisc., Hot Springs, Ark., and Corona, Calif., as well as the detinning operations of the company.

Table 6.—Stocks, receipts, and consumption of new and old aluminum scrap and sweated pig in the United States in 1972 [1]

(Short tons)

Class of consumer and type of scrap	Stocks Jan. 1 r	Receipts	Consumption	Stocks Dec. 31
Secondary smelters: [2]				
New scrap:				
Solids:				
Segregated low copper (Cu maximum, 0.4%)	5,990	131,608	133,028	4,570
Segregated high copper	858	14,779	15,083	554
Mixed low copper (Cu maximum, 0.4%)	3,358	77,572	78,002	2,928
High zinc (7000 series type)	330	9,199	9,059	470
Mixed clips	2,102	68,270	67,732	2,640
Borings and turnings:				
Low copper (Cu maximum, 0.4%)	W	W	W	W
Zinc, under 0.5%	W	W	W	W
Zinc, 0.5% to 1.0%	W	W	W	W
Foil, dross, skimmings	13,619	78,641	85,090	7,170
Other new scrap	1,726	30,601	30,854	1,473
Total new scrap	30,883	511,582	517,455	25,010
Old scrap (solids)	7,032	118,073	117,741	7,364
Sweated pig (purchased for own use)	5,714	70,228	71,288	4,654
Total all classes	43,629	699,883	706,484	37,028
Primary producers, foundries, fabricators, chemical plants:				
New scrap:				
Solids:				
Segregated low copper (Cu maximum, 0.4%)	4,389	176,234	175,991	4,632
Segregated high copper Mixed low copper (Cu maximum, 0.4%)	19,293	122,730	125,679	16,344
High zinc (7000 series type)	30	1,629	1,641	18
Mixed clips	74	7,292	7,238	128
Borings and turnings:				
Low copper (Cu maximum, 0.4%)	W	W	W	W
Zinc, under 0.5%	W	W	W	W
Zinc, 0.5 to 1.0%	W	W	W	W
Foil, dross, skimmings	2,883	15,670	17,777	776
Other new scrap	332	55,292	54,234	1,390
Total new scrap [3]	27,085	379,569	383,239	23,415
Old scrap (solids)	159	38,189	34,083	4,265
Sweated pig (purchased for own use)	4,925	28,516	28,627	4,814
Total all classes	32,169	446,274	445,949	32,494
Total of all scrap consumed:				
New scrap:				
Solids:				
Segregated low copper (Cu maximum, 0.4%)	10,379	307,842	309,019	9,202
Segregated high copper	899	21,267	21,567	599
Mixed low copper (Cu maximum, 0.4%)	22,610	193,814	197,197	19,227
High zinc (7000 series type)	360	10,828	10,700	488
Mixed clips	2,176	75,562	74,970	2,768
Borings and turnings:				
Low copper (Cu maximum, 0.4%)	474	29,408	29,094	788
Zinc, under 0.5%	619	15,684	15,971	332
Zinc, 0.5% to 1.0%	1,891	56,542	54,221	4,212
Foil, dross, skimmings	16,502	94,311	102,867	7,946
Other new scrap	2,058	85,893	85,088	2,863
Total new scrap [3]	57,968	891,151	900,694	48,425
Old scrap (solids)	7,191	156,262	151,824	11,629
Sweated pig (purchased for own use)	10,639	98,744	99,915	9,468
Total all classes	75,798	1,146,157	1,152,433	69,522

r Revised.
[1] Includes imported scrap.
[2] Excludes secondary smelters owned by primary aluminum companies.
[3] Includes data withheld.

Table 7.—Production and shipments of secondary aluminum alloys by independent smelters

(Short tons) [1]

	1971		1972	
	Production [2]	Shipments [2]	Production [2]	Shipments [2]
Pure aluminum (Al minimum, 97.0%)	85,265	85,772	79,535	77,455
Aluminum-silicon:				
95/5 Al-Si, 356, etc. (Cu maximum, 0.6%)	18,236	18,023	18,769	18,907
13 percent Si, 360, etc. (Cu maximum, 0.6%)	43,962	44,477	56,738	57,184
Aluminum-silicon (0.6% to 2% Cu)	5,313	5,647	3,874	4,106
No. 12 and variations	6,649	6,196	9,029	8,658
Aluminum-copper (Si maximum, 1.5%)	469	535	1,068	952
No. 319 and variations	46,882	47,590	50,681	50,815
Nos. 122 and 138	1,339	1,335	18	43
380 and variations	322,106	326,692	380,103	382,781
Aluminum-silicon-copper-nickel	16,741	16,320	8,576	9,324
Deoxidizing and other destructive uses:				
Grades 1 and 2	15,771	15,415	15,811	15,841
Grades 3 and 4	8,314	8,270	6,062	6,322
Aluminum-base hardeners	4,282	4,276	5,732	5,704
Aluminum-magnesium	881	848	2,042	1,985
Aluminum-zinc	4,134	4,346	8,073	8,059
Miscellaneous	26,113	26,315	33,953	34,256
Total	606,457	612,057	680,064	682,892

[1] Gross weight, including copper, silicon, and other alloying elements. Secondary smelters used 16,137 and 16,300 tons of primary aluminum in 1971 and 1972, respectively, in producing secondary aluminum-base alloys.
[2] No allowance was made for consumption or receipts by producing plants.

CONSUMPTION

Aluminum demand continued strong in 1972, and consumption, as measured by shipments of aluminum ingot and mill products to domestic users, surged upward by 16%. Total shipments including exports increased by 15%

The transportation market, representing the second largest market for aluminum products, gained about 24% over the previous year, and had the largest percentage and quantity increase of any of the major markets. The estimated average use of aluminum in 1973 model cars was about 78 pounds per unit. The engine block of the Vega continued to be made of aluminum, but its producer, General Motors Corp., indicated that there were no plans for using aluminum in any of its other models. The company indicated, however, that aluminum was still under active consideration for use in the Wankel rotary combustion engine, which could be first offered in U.S. automobiles as an option in the Vega.[5]

[5] Metals Week. The Vega Aluminum Engine Block. V. 43, No. 10, Mar. 6, 1972, p. 3.

Table 8.—Distribution of end-use shipments of aluminum products

Industry	1971		1972	
	Quantity (thousand short tons)	% of total	Quantity (thousand short tons)	% of total
Building and construction	1,389	r 26.7	1,584	26.5
Transportation	896	17.2	1,107	18.5
Containers and packaging	757	14.5	908	15.2
Electrical	712	13.7	762	12.7
Consumer durables	485	9.3	553	9.2
Machinery and equipment	321	r 6.1	368	6.1
Other markets	362	r 7.0	427	7.1
Total to domestic users	4,922	r 94.5	5,709	95.3
Exports	285	r 5.5	281	4.7
Total shipments	5,207	100.0	5,990	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	Imports (net) [1]	Recovery from old scrap [2]	Recovery from new scrap [2]	Total apparent consumption
1968	3,403,055	+443,464	154,711	662,197	4,663,427
1969	3,821,001	−11,419	148,205	752,625	4,710,412
1970	3,878,920	−141,796	145,576	635,843	4,518,543
1971	3,887,429	r +396,408	r 167,030	r 648,138	r 5,099,005
1972	4,177,190	+466,765	188,594	755,762	5,588,311

r Revised.
[1] Crude and semicrude. Includes ingot equivalent of scrap imports and exports (weight multipied by 0.9).
[2] Aluminum content.

The first domestic application of the Wankel engine was announced.[6] Limited production of the new type engine (to power a snowmobile), which utilized about 35 pounds of aluminum in the form of castings for the rotary housing and for other parts, was begun by the Outboard Marine Corp. at Waukegan, Ill.

Building and construction with a 14% gain over 1971 shipments continued to be the largest market for aluminum products. Residential aluminum siding, the largest single use of aluminum in construction, gained markedly. The use of aluminum in mobile homes, the second largest use in construction, achieved only moderate market gains despite a large increase in the number of mobile homes built in 1972 (about 600,000 units) compared with the number built in 1971 (500,000 units).

As in past recent years the use of all aluminum beverage cans continued to show phenomenal growth. A report[7] indicated that the commercial use of the all-aluminum beverage can began in the early 1960's, reached 3.2 billion units in 1969, continued to rise to 6.4 billion units in 1971, and was 8.4 billion units in 1972. Based on an assumed requirement of 0.06 pound of aluminum can sheet per unit, the total quantity shipped for all aluminum beverage cans in 1972 was approximately 250,000 short tons, representing about 28% of the total container and packaging market, which included all-aluminum cans for beverages and other purposes, composite cans, and aluminum lids, flexible packaging, foil, etc.

According to a report by the BDC, the use of aluminum for nonaluminum purposes declined from 295,248 short tons in 1965 to 259,229 tons in 1971.[8] The quantities of primary aluminum used in 1965 and 1971 were 52% and 59% of the total, respectively. Secondary aluminum ingot and aluminum scrap, dross, and skimmings made up the remainder. The end-use distribution for nonaluminum purposes in 1965 and 1971 was as follows:

	Short tons	
	1965	1971
Steel deoxidizing and production of ferroalloys		124,943
Steel alloying	169,731	28,890
Steel coating		13,365
Zinc-base alloys	48,521	36,688
Copper-base alloys	4,053	3,723
Anhydrous aluminum chloride and catalysts	72,943	23,732
Other [1]		27,888
Total	295,248	259,229

[1] Includes magnesium-base alloys, other nonaluminum base alloys, explosives, pyrotechnics, exothermic applications, and miscellaneous chemicals.

A review of the nonaluminum uses of aluminum in the United States, analyzing the BDC data and presenting a technical description of the end uses was published.[9] The steel uses accounted for about 65% of the nonaluminum consumption. The total quantity used in steel in 1971 was 1.5% less than in 1965, but steel output in 1971 was 8% less than in 1965, indicating a probable increase in the unit use of aluminum in steel during 1965–71.

[6] Modern Metals. Snowmobile's Debut First American-Made Wankel—In Aluminum. V. 28, No. 5, June 1972, pp. 28–32.
[7] Modern Metals. Cans Controversy: Time for a Truce. V. 28, No. 11, December 1972, pp. 47–62.
[8] U.S. Department of Commerce, Bureau of Domestic Commerce. Notice to Trade. Aluminum Ingot and Scrap in Non-Aluminum Uses 1971. BDC–782–09–73–008, Aug. 16, 1972, 2 pp.
[9] Metal Bulletin Monthly. Aluminum for Non-Aluminum. No. 24, December 1972, pp. 31–33.

Table 10.—Net shipments of aluminum wrought [1] and cast products by producers

(Short tons)

	1971	1972 p
Wrought products:		
Sheet, plate, foil	2,280,958	2,710,561
Rolled and continuous cast rod and bar, wire	498,968	556,384
Extruded rod, bar, pipe, tube, shapes; drawn and welded tubing and rolled structural shapes	1,010,287	1,162,653
Powder, flake, paste	83,762	113,610
Forgings (including impacts)	49,117	61,383
Total	3,923,092	4,604,591
Castings:		
Sand	96,434	114,820
Permanent mold	174,271	209,888
Die	513,112	596,086
Others	4,762	7,042
Total	[2] 788,579	r 927,836
Grand total	4,711,671	5,532,427

p Preliminary.
[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.
[2] Subject to possible upward revision of approximately 10% to 15%.

Table 11.—Distribution of wrought products

(Percent)

	1971	1972 p
Sheets, plate, and foil:		
Non-heat-treatable	48.0	48.8
Heat-treatable	2.7	2.8
Foil	7.5	7.3
Rolled and continuous cast rod and bar; wire:		
Rod, bar, etc	1.3	2.0
Bare wire, conductor and nonconductor	1.2	1.2
Bare cable (including steel-reinforced)	6.1	4.9
Wire and cable, insulated or covered	4.0	4.0
Extruded products:		
Rod and bar	.7	.6
Pipe and tubing	2.4	2.1
Shapes [1]	20.3	20.4
Tubing:		
Drawn	1.1	1.0
Welded, non-heat-treatable [2]	1.2	1.1
Powder, flake, and paste:		
Atomized	1.7	2.0
Flaked	(3)	(3)
Paste	.3	.3
Powder, n.e.c.	.2	.2
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

Reflecting the strong upturn in demand, industry stocks of primary aluminum ingot at reduction plants declined from 174,966 tons revised at the beginning of the year to 120,465 tons at the end. Although all producers do not report stocks of aluminum at reduction plants to the Bureau of Mines, BDC reported that the total metal inventory held by the aluminum industry, which includes stocks of all metal forms at reduction and other processing plants, also declined. Total industry stocks of aluminum metal, including scrap, dropped from 2,510,066 tons at the beginning of the year to 2,401,859 tons at the end.

PRICES

The quoted price for 99.5% pure primary aluminum ingot at the beginning of the year was 29 cents per pound. However, in the early part of 1972 most sales reportedly were in the 20-to 22-cent-per-pound range. Demand increased during the year and market prices began to improve. By yearend some sales were believed to be as high as 24 cents per pound. In May the quoted price was dropped to 25 cents per pound to bring it closer to market conditions.

FOREIGN TRADE

Exports of crude and semicrude aluminum metal, including scrap, in 1972 were 12% higher than in 1971. Aluminum scrap exports were more than double those of 1971. and accounted for most of the increase. Exports of ingots, slabs, and other crude forms actually declined. As in past years Canada was the principal destination of U.S. aluminum exports, receiving 35% of the crude and semicrude aluminum exported, chiefly in the form of plate, sheets, and bars. Canada, Argentina, Japan, and Belgium-Luxembourg, in that order, were the principal recipients of ingot, slabs, and other crude forms.

U.S. imports for consumption of crude and semicrude aluminum increased dramatically for the second successive year, reaching 794,485 short tons, 15% above 1971 imports. Aluminum in the form of metal and alloys, ingots, and other crude forms, as in past years dominated imports, accounting for 83% of the total. Scrap imports declined sharply during the year to 52,301 tons. As in past years Canada was the principal source of U.S. aluminum imports, accounting for 77% of the ingot and other crude forms, and for 85% of the scrap imports. Other principal sources of imported ingot and other crude forms were Norway, Ghana, the United Kingdom, and France.

Table 12.—U.S. exports of aluminum, by class

Class	1971		1972	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Crude and semicrude:				
Ingots, slabs, crude	112,295	$58,040	108,319	$51,879
Scrap	30,675	9,995	66,039	21,072
Plates, sheets, bars, etc	r 141,133	r 111,827	144,987	115,279
Castings and forgings	3,561	8,245	4,467	11,681
Semifabricated forms, n.e.c	5,801	9,443	5,282	9,329
Total	r 293,465	r 197,550	329,094	209,240
Manufactures:				
Foil and leaf	8,295	11,892	7,459	11,828
Powders and pastes	1,741	1,646	2,757	2,110
Wire and cable	r 15,452	r 10,137	10,229	9,050
Total	r 25,488	r 23,675	20,445	22,988
Grand total	r 318,953	r 221,225	349,539	232,228

r Revised.

Table 13.—U.S. exports of aluminum, by class and country

Country	1971						1972					
	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	10,180	$5,472	148	$294	--	--	16,222	$6,405	1,799	$873	1	(2)
Australia	137	86	898	1,107	3	$1	49	35	1,053	1,251	3	$1
Belgium-Luxembourg	13,175	5,634	160	325	221	67	11,427	4,956	269	454	522	164
Brazil	2,847	1,543	1,334	1,258	--	--	2,506	1,089	1,632	1,705	1,187	323
Canada	9,166	5,439	93,787	68,379	6,449	2,411	19,058	10,186	91,589	72,876	4,312	1,528
Chile	1,421	754	498	385	--	--	407	224	10	19	12	4
Colombia	4	5	186	226	2	2	4	5	281	301	5	2
El Salvador	842	483	515	330	--	--	1,429	692	549	329	--	--
France	3,829	1,937	658	1,065	185	65	1,647	938	821	1,099	386	155
Germany, West	11,705	6,203	7,727	9,939	10,755	3,257	8,887	4,344	5,264	7,533	12,873	3,659
Ghana	147	234	2,054	1,424	--	--	301	223	105	95	--	--
Hong Kong	413	216	86	109	35	8	1,742	877	474	475	--	--
India	9,625	4,611	236	273	--	--	5	3	45	108	--	--
Iran	3,145	1,601	72	122	--	--	3,272	1,489	214	196	5	2
Israel	829	471	720	1,000	--	--	22	13	720	979	--	--
Italy	1,590	1,348	3,318	5,648	2,201	647	888	576	2,783	4,083	1,854	494
Jamaica	27	28	194	273	12	4	13	15	223	270	17	4
Japan	14,132	7,087	2,029	2,757	5,539	1,722	13,956	6,583	4,466	5,151	31,405	10,256
Korea, Republic of	411	216	156	209	815	269	519	240	161	201	6,794	2,392
Mexico	202	100	4,433	3,494	219	26	524	286	10,162	6,607	287	32
Netherlands	638	460	3,548	3,956	408	140	1,575	966	3,043	3,156	294	91
New Zealand	919	510	162	210	--	--	879	473	307	310	--	--
Norway	457	256	108	179	--	--	48	67	387	403	--	--
Pakistan	352	195	993	685	--	--	665	330	581	363	742	209
Panama	985	521	250	332	2	1	545	257	69	104	2	1
Peru	568	305	158	142	941	503	93	49	98	166	799	403
Philippines	7,183	3,690	50	147	68	28	5,013	2,512	153	217	66	37
South Africa, Republic of	359	204	r 3,509	r 3,094	--	--	1	2	2,284	2,074	--	--
Spain	561	250	55	98	825	176	3	1	511	422	1,627	321
Sweden	922	595	933	981	50	17	7	5	924	1,057	--	--
Switzerland	588	321	263	347	--	--	1,917	943	862	900	--	--
Taiwan	2,914	1,402	204	270	297	78	6,146	2,549	200	319	991	420
Thailand	6,601	2,395	37	50	--	--	4,818	2,221	25	43	--	--
United Kingdom	886	573	11,906	11,036	821	288	1,241	722	13,703	13,007	1,266	368
Venezuela	59	74	1,725	1,701	3	1	97	102	1,583	1,599	1	1
Other	4,476	2,821	7,385	7,670	824	284	2,393	1,501	7,386	7,544	588	205
Total	112,295	58,040	r 150,495	r 129,515	30,675	9,995	108,319	51,879	154,736	136,289	66,039	21,072

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	1971 Quantity (short tons)	1971 Value (thousands)	1972 Quantity (short tons)	1972 Value (thousands)
Crude and semicrude:				
Metals and alloys, crude	554,208	$257,473	661,042	$304,536
Circles and disks	8,041	5,404	9,907	6,597
Plates, sheets, etc., n.e.c	55,756	35,211	59,616	36,941
Rods and bars	7,147	5,087	9,428	6,671
Pipes, tubes, etc	1,845	1,789	2,191	2,242
Scrap	62,840	r 22,004	52,301	17,747
Total	689,837	r 326,968	794,485	374,734
Manufactures:				
Foil	12,912	14,271	12,266	14,851
Leaf (5.5 by 5.5 inches)	(1)	47	(1)	84
Flakes and powders	1,403	1,527	225	298
Wire	622	633	743	542
Total	14,937	16,478	13,234	15,775
Grand total	704,774	r 343,446	807,719	390,509

r Revised.

1 1971: 2,932,166 leaves and 41,431,436 square inches; 1972: 7,959,116 leaves and 167,764,497 square inches.

Table 15.—U.S. imports for consumption of aluminum, by class and country

Crude	1971						1972					
	Metals and alloys, crude		Plates, sheets, bars, etc.[1]		Scrap		Metals and alloys, 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)
Australia	119	$54	166	$116	--	--	--	--	3	$3	--	--
Austria	--	--	1,657	1,219	--	--	5	$3	2,376	1,699	--	--
Belgium-Luxembourg	20	7	26,069	15,633	--	--	--	--	35,299	20,551	31	$8
Canada	440,861	201,265	6,773	5,309	34,221	$12,053	508,231	230,211	5,522	4,777	44,452	15,399
France	2,162	1,105	12,337	8,330	292	123	17,220	8,408	14,225	9,374	--	--
Germany, West	2	5	728	736	9,792	3,357	8	8	1,033	1,047	1,843	515
Ghana	35,132	18,755	--	--	--	--	40,618	19,467	--	--	133	68
Italy	2	7	3,679	2,553	(2)	1	220	57	3,975	2,734	(2)	(2)
Japan	511	229	13,352	8,356	--	--	170	131	8,950	5,902	--	--
Mexico	8	1	--	--	646	118	4,967	2,829	17	24	775	124
Norway	53,901	25,704	3	2	3,665	1,310	63,909	31,077	293	157	25	9
Poland	1,294	511	32	17	--	--	551	193	--	--	--	--
Spain	1,831	757	2,256	1,303	384	152	--	--	1,013	648	--	--
Sweden	60	21	280	202	430	168	--	--	100	95	225	85
Switzerland	1	4	224	190	383	130	--	--	226	192	--	--
U.S.S.R.	148	120	--	--	4,404	1,476	65	56	--	--	--	--
United Kingdom	6,729	3,722	210	235	8,021	2,906	24,516	11,819	184	208	4,040	1,275
Yugoslavia	220	85	4,465	2,972	--	--	6	3	6,330	4,110	--	--
Other	11,207	5,121	558	318	602	r 210	561	274	1,596	930	777	264
Total	554,208	257,473	72,789	47,491	62,840	r 22,004	661,042	304,536	81,142	52,451	52,301	17,747

r Revised.
[1] Includes circles, disks, bars, rod, plates, sheets, pipes, etc.
[2] Less than ½ unit.

WORLD REVIEW

Despite predictions to the contrary, world aluminum demand surged ahead in 1972, increasing 10% above that in 1971. By yearend the industry's oversupply problem, which was at its worst in 1970 and 1971, appeared to be over as production gained 6.4% above the 1971 level. Capacity in several countries, which had been shut down in 1970–71, was reopened. In addition world production capacity at the end of 1972 was only 4% higher than at the end of 1971.

In response to the 1970–71 oversupply, the Organization for Economic Cooperation and Development (OECD) undertook a detailed study of world aluminum industry problems. The study included an analysis of world trends in demand, production, trade, stocks, prices, and costs and was expected to be released in 1973.

A report by the Organization of European Aluminium Smelters (OEA) described the economic development of the secondary aluminum industry in Europe and reviewed the secondary aluminum industry in the United States and Japan.[10]

[10] Organization of European Aluminium Smelters. Aluminium Smelters—Europe, Japan, USA—1971–1972. English Edition, June 1972, p. 44 (available from Dr. G. Uhlig, Secretariat, Organization of European Aluminium Smelters, Graf-Adolph-Strasse 18, D-4000 Dusseldorf 1, Germany).

Table 16.—Aluminum: World production, by country [1]

(Thousand short tons)

Country	1970	1971	1972 p
North America:			
Canada	1,072	1,121	e 1,020
Mexico	37	44	44
United States	3,976	3,925	4,122
South America:			
Brazil	r 63	98	107
Surinam	61	60	62
Venezuela	25	25	26
Europe:			
Austria	99	100	93
Czechoslovakia	34	41	e 42
France	420	423	433
Germany, East e	65	65	65
Germany, West	341	471	490
Greece	96	128	143
Hungary	73	74	75
Iceland	42	45	50
Italy	161	132	134
Netherlands	83	128	183
Norway	r 576	584	604
Poland [2]	109	110	112
Romania [3]	112	123	134
Spain	r 132	139	154
Sweden	r 71	83	85
Switzerland	101	104	92
U.S.S.R. e	1,212	1,300	1,380
United Kingdom	44	131	189
Yugoslavia	53	51	64
Africa:			
Cameroon	58	56	53
Ghana	125	122	159
South Africa, Republic of	--	32	58
Asia:			
Bahrain	--	11	82
China, People's Republic of e	140	150	150
India	178	196	197
Iran	--	--	7
Japan [4]	808	985	1,119
Korea, Republic of	17	19	17
Taiwan	30	29	35
Oceania:			
Australia	r 227	246	227
New Zealand	--	24	e 96
Total	r 10,641	11,375	12,103

e Estimate. p Preliminary. r Revised.
[1] Output of primary unalloyed ingot unless otherwise specified.
[2] Includes secondary.
[3] Includes alloys.
[4] Includes super-purity aluminum as follows in tons: 1970—5,409; 1971—6,706; 1972—6,313.

Table 17.—World producers of primary aluminum

(Thousand short tons)

Country, company, plant location	Capacity, yearend 1972	Ownership
NORTH AMERICA		
Canada:		
Aluminum Company of Canada, Ltd.:		Alcan Aluminium Ltd., 100%.
Arvida, Quebec	458	
Beauharnois, Quebec	52	
Isle Maligne, Quebec	130	
Kitimat, British Columbia	300	
Shawinigan Falls, Quebec	95	
Total	1,035	
Canadian Reynolds Metals Co. Ltd.: Baie Comeau, Quebec	175	Reynolds Metals Co., 100%.
Total Canada	1,210	
Mexico: Aluminio, S.A. de C.V.: Vera Cruz	44	Aluminum Co. of America, 44%; private Mexican interests, 56%.
United States (see table 3)	4,744	
Total North America	5,998	
SOUTH AMERICA		
Brazil:		
Aluminio Minas Gerais, S.A.:		Alcan Aluminium Ltd., 100%.
Saramenha, Minas Gerais	30	
Arutü, Bahia	11	
Cia. Brasileira de Alumínio S.A. (CBA): Sorocaba, São Paulo	44	Industria Votorantim, Ltd., 80%; Government, 20%.
Companhia Mineira de Alumínio, S.A.: Poços de Caldas, Minas Gerais	28	Aluminum Co. of America, 50%; Hanna Mining Co., 23.5%; Minas Gerais State, 26.5%.
Total Brazil	113	
Surinam: Suriname Aluminium Co. (Suralco): Paranam	73	Aluminum Co. of America, 100%.
Venezuela: Aluminio del Caroni, S.A. (Alcasa): Matanzas	25	Reynolds Metals Co., 50%; Government, 50%.
Total South America	211	
EUROPE		
Austria:		
Salzburger Aluminium G.m.b.H. (SAG): Lend, Salzburg	13	Alusuisse, 100%.
Vereinigte Metallwerke Ranshofen-Berndorf, A.G. (VMRB): Ranshofen, Braunau-am-Inn	88	Government, 100%.
Total Austria	101	
Czechoslovakia: Ziar Aluminium Works: Ziar-on-Hron	72	Government, 100%.
France: Péchiney Ugine Kuhlmann Group (PUK):		Self, 100%.
Auzat, Ariége	33	
Chedde, Haute-Savoie	9	
La Praz, Savoie	4	
L'Argentiére, Haute-Alpes	42	
La Saussaz, Savoie	13	
Nogueres, Basses-Pyrénées	123	
Rioupéroux-Isére	26	
St. Jean de Maurienne-Savoie	91	
Sabart-Ariége	26	
Lannemezan-Haute Pyrénées	58	
Venthon-Savoie	28	
Total France	453	
Germany, East: Electrochemisches Kombinat:		Government, 100%.
Bitterfeld	55	
Lautawerk	33	
Total Germany, East	88	
Germany, West:		
Aluminium-Hütte Rheinfelden G.m.b.H.: Rheinfelden, Baden	61	Alusuisse, 99.85%.
Vereinigte Aluminium-Werke A.G. (VAW):		Government, 100%.
Erftwerke, Grevenbroich	40	
Innwerke, Toeging	77	
Lippenwerke, Lunen	55	
Norf, Rheinwerke	154	

Table 17.—World producers of primary aluminum—Continued

(Thousand short tons)

Country, company, plant location	Capacity, yearend 1972	Ownership
EUROPE—Continued		
Germany, West;—Continued		
Gebrueder Giulini G.m.b.H.: Ludwigshafen	22	Self, 100%.
Kaiser-Preussag Aluminium G.m.b.H.:		Kaiser, 50%; Preussag A. G., 50%.
Voerde	71	
Leichtmetall G.m.b.H.: Essen	139	Metallgesellschaft A.G., 50%; Alusuisse, 50%.
Total Germany, West	619	
Greece: Aluminium de Grèce S.A. (ADG):		Péchiney, 72%; Ugine, 18%; Government, 10%.
Distomon	160	
Hungary: Magyarsoviet Bauxite Ipar:		Government, 100%.
Ajka	19	
Inota	33	
Tatabanya	17	
Total Hungary	69	
Iceland: Icelandic Aluminium Co. Ltd.:		Alusuisse, 100%.
Straumsvik	83	
Italy:		
Alcan Alluminio Italiano S.p.A.: Borgo-Franco d'Ivrea	6	Alcan Aluminium Ltd., 100%.
Montecatini Edison S.p.A.:		Government, 11%; Montecatini Edison, 89%.
Bolzano	66	
Fusina	40	
Mori	26	
Societá Alluminio Veneto per Azioni S.p.A. (S.A.V.A.):		Alusuisse, 93.75%.
Fusina	33	
Porto Marghera	33	
Total Italy	204	
Netherlands:		
Aluminium Delftzijl N.V. (Aldel): Delftzijl	106	Holland Aluminium N.V., 100%.
Péchiney Nederland N.V.: Vlissingen (Flushing)	94	Péchiney, 100%.
Total Netherlands	200	
Norway:		
Alnor A/S (Alnor): Karmay Island	115	Harvey, 49%; Norsk Hydro, 51%.
A/S Ardal og Sunndal Verk (ASV):		Government, 50%; Alcan, 50%.
Ardal	193	
Høyanger	33	
Sunndalsora	132	
Det Norske Nitridaktieselskap (DNN):		Alcan, 50%; British Aluminium, 50%.
Eydehavn	14	
Tysseldal	31	
Mosjøen Aluminiumverk A/S (Mosal):		Alcoa, 50%; Elkem, 50%.
Mosjøen	105	
Søer-Norge Aluminium A/S (Soral): Husnes	77	Alusuisse, 100%.
Lista Aluminiumverk A/S (Elkem): Lista	62	Alcoa, 50%; Elkem, 50%.
Total Norway	762	
Poland: Ministry of Heavy Industry:		Government, 100%.
Konin Works	61	
Skawina Works	61	
Total Poland	122	
Romania:		
Slatina	112	Government, 100%
Tarnaveni	13	
Total Romania	125	
Spain:		
Aluminio de Galicia, S.A. (Alumigasa):		Péchiney, 66%; ENDASA, 17%; Government, 17%.
La Coruna	61	
Sabinanego, Huesca	15	
Empresa Nacional del Aluminio, S.A. (ENDASA):		Government, 54%; Alcan, 25%; Spanish interests, 21%.
Aviles	64	
Valadolid	27	
Total Spain	167	

Table 17.—World producers of primary aluminum—Continued

(Thousand short tons)

Country, company, plant location	Capacity, yearend 1972	Ownership
EUROPE—Continued		
Sweden: A/B Svenska Aluminiumkompaniet (Sako):		Svenska Metallverken, 79%; Alcan 21%.
Sundsvall, Kubikenborg	95	
Switzerland:		
Swiss Aluminium Ltd. (Alusuisse):		Alusuisse, 100%.
Chippis	35	
Steg	53	
Usine d'Aluminium Martigny, S.A.:		Self, 100%.
Martigny	12	
Total Switzerland	100	
United Kingdom:		
Alcan (U.K.) Ltd: Lynemouth, Northumberland	66	Alcan, 100%.
Anglesey Aluminium Ltd: Holyhead, New Wales, Scotland	112	Rio Tinto-Zinc Corp., Ltd., 47%; Kaiser Aluminum & Chemical Corp., 34%; British Insulated Callenders Cables, Ltd., 19%.
The British Aluminium Co., Ltd. (Baco):		Tube Investments, Ltd., 49%; Reynolds Metals Co., 48%.
Kinlochleven, Scotland	11	
Lochaber (Fort William), Scotland	32	
Invergordon, Scotland	112	
Total United Kingdom	333	
U.S.S.R.:		
Bogoslovsk (Krasnoturinsk), Sverdlovskaya Oblast, Urals	154	Government, 100%.
Bratsk, Irkutskaya Oblast, Siberia	220	
Irkutsk (Shelekovo), Irkutskaya Oblast, Siberia	220	
Kamensk-Ural'skiy, Sverdlovskaya Oblast, Urals	154	
Kanaker (Yerevan), Armenia	83	
Kandalaksha, Murmanskaya Oblast	33	
Krasnoyarsk, Krasnojarskiy Kray, Siberia	220	
Nadvoitsy, Karelskaya, A.S.S.R	39	
Novo-kuznetsk (Stalinsk), Kemeroyskaya Oblast, Siberia	138	
Sumgait (Kirovabad), Azerbaijan	83	
Volgograd (Stalingrad) Volgogradskays Oblast	135	
Volkhov (Zvanka), Leningrad Oblast	22	
Zaporozhye (Dneprovsk), Zaporozhskaya Oblast, Ukraine	77	
Total U.S.S.R	1,578	
Yugoslavia: Yogoslovenisk:		Government, 100%.
Kidricevo, Slovenia	55	
Lozovac, Croatia	7	
Razine, Croatia	4	
Titograd, Montenegro	55	
Total Yugoslavia	121	
Total Europe	5,452	
AFRICA		
Cameroon: Compagnie Camerounaise de l'Aluminium, Péchiney-Ugine (Alucam):		Péchiney, 48%; Ugine, 12%; Cobeal, 10%; Comal Cie, 30%.
Edea	61	
Ghana: Volta Aluminium Corp. (Valco):		Kaiser, 90%; Reynolds, 10%.
Tema	162	
South Africa, Republic of: Alusaf (Pty) Ltd.:		Aluminium Investment Co., 66.66%; Light Metal Investments Co., 33.34%.
Richards Bay	57	
Total Africa	280	
ASIA		
Bahrain: Aluminium Bahrain Ltd. (ALBA)	132	Kaiser Aluminium, General Cable, British Metals, 17% each; Western Metals, 8.5%; Bretton Investments, 9.5%; Electro-Kopper, 12%; Bahrain Government, 19%.

Table 17.—World producers of primary aluminum—Continued

(Thousand short tons)

Country, company, plant location	Capacity, yearend 1972	Ownership
ASIA—Continued		
China, People's Republic of:		
Fushun, Kiaoning		Government, 100%.
Taiyuan, Shansi		
Lanchow, Kansu		
Hefei, Anhwei		
Changchun, Chilin	220	
Tsingtao, Shantung		
Jiaozuo, Honan		
Wuhan, Hupei		
Hunan, Hunan		
Changsha, Hunan		
Total China, People's Republic of	220	
India:		
Aluminium Corp. of India Ltd. (Alucoin): Asansol, West Bengal	10	Self, 100%.
Hindustan Aluminium Corp. Ltd. (Hindalco): Rennkoot, Uttar Pradesh	105	Kaiser, 27%; Birla and Indian interests, 73%.
Indian Aluminium Co. Ltd. (Indal):		Alcan, 55%; Indian interests, 45%.
Belgaum, Bombay	52	
Alupuram, Kerala	20	
Hirakud, Orissa	25	
Madras Aluminium Co. Ltd. (Malco): Mettur, Madras	15	Montecatini Edison, 27%; Madras State Government, 73%.
Total India	227	
Iran: Iran Aluminium Co. (IRALCO): Arak	50	Iranian Government, 77.7%; Reynolds Metals Co., 17.3%; Pakistani Government, 5%.
Japan:		
Mitsubishi Chemical Industries, Ltd.:		Self, 100%.
Naoestu	173	
Sakaide	99	
Nippon Light Metal Co., Ltd. (NKK):		Alcan, 50%; Japanese interests, 50%.
Kambara	122	
Hokkaido (Tomakomai)	143	
Niigata	109	
Showa Denko K.K.:		Self, 100%.
Chiba 1	150	
Kitakata	47	
Omachi	46	
Sumitomo Chemical Co., Ltd.:		Self, 100%.
Isoura	84	
Kikumoto	26	
Nagoya	55	
Toyama	123	
Mitsui Aluminum Industry Co., Ltd.: Omuta	83	Self, 100%.
Total Japan	1,260	
Korea, Republic of: Han Kuk Aluminium Co. (Han Kuk): Ulsan	18	Korean interests, 100%.
Taiwan: Taiwan Aluminium Corp. (Taialco): Kaohsiung, Takao	42	Government, 100%.
Total Asia	1,949	
OCEANIA		
Australia:		
Alcan Australia, Ltd.: Kurri-Kurri	50	Alcan, 80%, other interests, 20%.
Alcoa of Australia Pty. Ltd.: Point Henry (Geelong)	99	Alcoa, 51%; Australian interests, 49%.
Comalco Industries Pty. Ltd.: Bell Bay, Tasmania	104	Kaiser, 50%; Conzinc Rio Tinto of Australia, Ltd., 50%.
Total Australia	253	
New Zealand: New Zealand Aluminium Smelters Ltd.: Bluff	123	Comalco Industries, Pty. Ltd., 50%; Sumitomo Chemical Co., 25%; Showa Denko K.K., 25%.
Total Oceania	376	
Total world	14,266	

The International Primary Aluminum Institute (IPAI), comprising some 50 member companies operating 130 primary aluminum plants throughout the world, was founded in April. The objective of IPAI was to publicize the properties of aluminum, promote new uses, collect statistics, study environmental problems, and make known the industry's accomplishments. The management of the institute, which established its headquarters in London, was largely delegated to a board of 12 directors, elected by the members for a 2-year term.

Argentina.—Construction of the 140,000-ton-per-year primary aluminum plant at Puerto Madryn apparently continued, but initial output was rescheduled to August 1974, 6 months behind the original startup date. Imports of aluminum metal were restricted to insure that imports met only established needs and did not result in increased inventories prior to the opening of the Puerto Madryn facility.

Bahrain.—The fourth and last planned potline at the primary aluminum plant of Aluminium Bahrain Ltd. was completed late in the year, bringing the plant's annual capacity to about 132,000 short tons.

Cameroon.—Domestic consumption of aluminum reportedly was 13% of production in 1968, 15% in 1969, and 21% in 1970.

Ceylon.—Long-range plans for a 7,500-ton-per-year primary aluminum plant to be expanded eventually to 20,000 tons per year reportedly were approved by the Government. Estimated demand for aluminum was believed to be about 10,000 tons per year.

China, People's Republic of.—Imports of aluminum metal have risen sharply in recent years, and totaled approximately 100,000 tons in 1972. One report attributed the increased demand to development of new hydroelectric power supplies and the concommitant requirement for electrical conductors made of aluminum.[11]

Egypt, Arab Republic of.—The 110,000-ton-per-year primary aluminum plant being built at Nag Hammadi, under a cooperative agreement with the U.S.S.R., was about half completed at yearend, but initial output was not expected until late in 1974.

Hungary.—A study by the National Technical Development Board forecast the consumption of aluminum in 1985 at 250,000 to 300,000 tons, equivalent to an average annual growth rate of 7%. The use pattern during the forecast period was expected to shift toward increased use of aluminum in the construction, agricultural, chemical, and packaging industries, whereas the growth rate of aluminum uses in the automobile, electrical, and domestic goods sectors was expected to slow somewhat.

Iceland.—The primary aluminum plant operated by the Icelandic Aluminium Co., Ltd. (ISAL) at Straumsvik was the first major industry to utilize the island's hydroelectric potential, believed to be about 1 million kilowatts. Production capacity of the ISAL smelter, which along with other users taps only 7% of the potential hydroelectric power, was expanded to about 83,000 tons per year at the end of 1972 by the addition of a 120-cell potline and a second alumina storage silo of 40,000 tons capacity.

India.—Output and capacity of primary aluminum continued to expand and further growth was planned. In the private sector, Aluminium Corp. of India, Ltd. (Alucoin) abandoned plans to expand its Asansol primary aluminum smelter by 3,800 tons by 1973 because of the shortage of power. This firm reportedly received Government approval for construction of a second aluminum smelter with an annual capacity of 16,000 tons at Rayagada, Orissa. Hindustan Aluminium Corp., Ltd. (Hindalco) completed a 17,000-ton-per-year expansion of its Rennkoot smelter in 1972 and was adding another 23,000 tons per year to be completed late in 1974. The Indian Aluminium Co., Ltd., had provisional approval from the Government to expand its Belgaum primary aluminum plant by 22,000 tons per year. Capacity of the Mettur primary aluminum smelter operated by the Madras Aluminium Co., Ltd., was expected to be raised to 28,000 tons per year by 1976.

In the public sector the Government, through its Bharat Aluminium Co., planned to construct a 110,000-ton-per-year primary aluminum plant at Korba, Madhya Pradesh, and a 55,000-ton-per-year plant at Koyna, Maharashtra. Operational

[11] Engineering and Mining Journal. More on Mainland China: A New Survey of Nonferrous Metals Industries. V. 173, No. 6, June 1972, p. 38.

dates of these two plants were scheduled for 1973 and 1975, respectively.

Completion of all of the planned expansions would bring total aluminum production capacity to about 485,000 tons per year by the 1975–76 period, making the country self-sufficient in aluminum.

Indonesia.—Meetings were held during the year between Japanese and U.S. aluminum firms to discuss the possible construction and operation of a 220,000-ton-per-year primary aluminum plant in North Sumatra. Power for the plant was to come from hydroelectric facilities at Asahan. Participating companies reportedly included Nippon Light Metal Co. Ltd., Showa Denko K.K., Sumitomo Chemical Co. Ltd., Mitsubishi Chemical Industries, Ltd., Mitsui Aluminium Industry Co., Alcoa, and Kaiser. Financial arrangements for the power facilities and the time that construction of the power facilities would begin were not established at the end of 1972.

Iran.—The Iranian Aluminium Co. (IRALCO) began production of primary aluminum from its new 50,000-ton-per-year smelter at Arak in May, and the facility was officially opened in September. The plant, which utilized prebaked anodes, was scheduled to reach full production in March 1973.

Italy.—Alluminio Sardo-ALSAR, owned by the state organization Ente Participazione Finanziamento Industria Manifattura (EFIM) and Montecatini Edison S.p.A., was expected to begin commercial production of primary aluminum at its new 110,000-ton-per-year plant at Porto Vesme, Sardinia, early in 1973. A $500 million to $700 million electrochemical complex in Mazara del Vallo, Sicily was under construction by EFIM, Montecatini Edison, and another state organization, Ente Nazionale Idrocarburi (ENI), and was to include a 165,000-ton-per-year primary aluminum plant. The aluminum plant was expected to be operational by 1977 or 1978.

Japan.—Nippon Light Metal Co., Ltd., put into partial operation the first of two new potlines at its Niigata smelter. Full production on the first line was scheduled for 1973. The second line, which would raise capacity at Niigata to 153,000 tons per year, was to be brought in by 1974.

Mitsubishi Chemical Industries, Ltd., was reportedly considering an expansion at its newly completed Sakaide smelter. The project, to be completed in 1974, would add four new potlines, increasing capacity from 99,000 tons per year to 209,000 tons per year.

Furukawa Aluminium Co. (Furalco), owned by Alcoa (33.3%), Furukawa Electric Co. Ltd. (61.7%), and Nippon Light Metal Co. (5%), obtained Government approval to construct a 77,000-ton-per-year aluminum smelter in the Mikuni area of Fukui Prefecture in 1976. The $87.6 million smelter will use Alcoa's process for controlling fluoride emissions and will use purchased alumina from Western Australia. Ultimate capacity was set at 220,000 tons per year. Electricity will be supplied by a thermal power station jointly owned by Furalco and Hokuriki Power Corp. The smelter's output will be used in Furukawa's own fabricating plants.

Sumikei Aluminium Industries, Ltd., formed by the Sumitomo Group consisting of Sumitomo Light Metals Co. (40%), Sumitomo Chemicals Co. Ltd. (Sumika) (30%), Sumitomo Metal Industries (15%), Sumitomo Bank (5%), Sumitomo Trust and Banking (5%), and Sumitomo Shoji (5%), planned to construct a 99,000-ton-per-year aluminum smelter at Sakata, Yamagata Prefecture, scheduled to start production in October 1975. The plant eventually was expected to have a capacity of 200,000 tons per year. Electrical power was to be provided by a 350,000-kilowatt-capacity powerplant to be owned jointly by Sumikei Aluminium and Tohaku Electric Power Co.

Construction of the 82,000-ton-per-year primary aluminum plant planned by Kobe Steel Works, Ltd., for 1972 was postponed to mid-1976.

Korea, North.—The 1971 to 1976 development plan provided for a 20,000-ton-per-year aluminum plant but did not specify the type of plant. Some sources reported that three small primary aluminum plants were located in Hungnam, Chinnampo, and Tasado.

Korea, Republic of.—The Han Kuk Aluminium Co., which operates the only primary aluminum plant in South Korea, reportedly incurred financial difficulties and entered into an agreement with Péchiney Ugine Kuhlmann (PUK) whereby the capacity of the plant would be doubled to

36,000 tons per year by 1975. The new firm, to be jointly owned by Han Kuk and PUK, will be called The Daehan Aluminum Co.

Mexico.—Aluminio, S.A. de C.V., planned to increase annual capacity of its primary aluminum facility at Vera Cruz to 77,000 tons per year by 1975.

Netherlands.—Holland Aluminium N.V., jointly owned by Koninklijke Nederlandsiche Hoogovens en Staalfabrieken N.V. (Hoogovens) and N.V. Billiton Maatschappij (Billiton), acquired the one-third interest in the Aluminium Delftzijl N.V., 106,000-ton-per-year primary aluminum plant at Delftzijl, which was formerly owned by the Swiss Aluminium Co. (Alusuisse).

Papua.—A Japanese firm (Nippon Koei) was expected to survey port sites for the proposed Purari River hydroelectric project. The feasibility study of the project was expected to take 3 years and construction of a dam another 5 or 6 years. A primary aluminum plant was included in the long-range development plans.

Romania.—The primary aluminum plant at Slatina was being expanded to 220,000 tons per year. The expansion included four new potlines and was expected to be completed in 1975.

South Africa, Republic of.—Alusaf (Pty) Ltd. planned to increase production capacity at its Richards Bay primary aluminum plant to 82,000 short tons by the first half of 1974. The expansion was to be accomplished by addition of 66 new reduction cells to the existing 150 cells.

Taiwan.—Production capacity at the primary aluminum plant at Kaohsiung was expected to be increased to 77,000 tons per year by 1975.

United Kingdom.—Alcan (U.K.) Ltd. began initial production at its new Lynemouth primary aluminum plant in March. The plant uses alumina imported from Jamaica and eventually will use electric energy from its own 39,000-kilowatt, coal-fired powerplant nearby.

Yugoslavia.—Programs were continued to convert the country from an exporter of bauxite to an exporter of aluminum metal. The 55,000-ton-per-year primary aluminum plant under construction at Razine, near Šibenik in Croatia, was expected to begin initial production early in 1973. However, possible delay in construction of the electric power facilities could adversely affect future output.

TECHNOLOGY

Annual productivity of labor in domestic alumina reduction facilities between 1950 and 1972 has more than doubled, chiefly because of the use of larger reduction cells with better thermal characteristics and because of more careful control of operating conditions of individual cells. As shown in table 18, productivity in the aluminum industry has fluctuated at times and has been relatively unchanged during certain other periods. During the Korean War, productivity actually decreased from about 79 pounds per man-hour in 1950 to 73 pounds in 1953. During the next 2 years it increased rapidly to 93 pounds in 1955, but by 1957 it had increased to only 99 pounds. After 1957 it rose steadily to 152 pounds in 1962, and the rate of increase again slowed after 1963 to the 1969 level of 179 pounds per man-hour.

Aside from technologic improvements, a number of other factors apparently contribute to a decline in productivity or to a slowing down of the rate of increase. For example, an emergency condition or a period of rapid expansion of production facilities coupled with low utilization of capacity by established producers, or the entrance of new producers, historically has been accompanied by a decline or leveling off in productivity. During long-drawn-out periods of low-capacity utilization, such as that which occurred during 1970 and 1971, older, less efficient plants were shut down, and since relatively few new producers entered the field, overall worker productivity increased substantially. The high productivity in 1970 and 1971 is indicative of the improvement that can be expected in future years.

Alcoa announced the development of a new process for producing primary aluminum metal. In this process, which reportedly was developed after 15 years of research costing $25 million, alumina is reacted with chlorine to form aluminum chloride which is electrolyzed in a completely closed cell to produce molten alu-

Table 18.—Productivity in the aluminum industry [1]

Year	Production workers [2]		Production (thousand short tons)	Man-hours per ton of aluminum produced	Pounds of aluminum produced per man-hour
	Number (thousands)	Million man-hours			
1950	8.9	18.2	719	25.3	79
1951	10.1	22.0	837	26.3	76
1952	11.7	24.9	937	26.6	75
1953	16.7	34.2	1,252	27.3	73
1954	17.0	35.3	1,461	24.2	83
1955	16.4	33.9	1,566	21.6	93
1956	17.0	34.8	1,679	20.7	97
1957	16.3	33.4	1,648	20.3	99
1958	13.4	27.7	1,566	17.7	113
1959	14.4	30.0	1,954	15.4	130
1960	14.1	29.1	2,014	14.4	139
1961	12.7	26.1	1,904	13.7	146
1962	13.7	27.9	2,118	13.2	152
1963	14.5	29.5	2,313	12.8	156
1964	16.7	32.0	2,553	12.5	160
1965	16.8	33.5	2,754	12.2	164
1966	17.1	34.7	2,968	11.7	171
1967	19.2	38.4	3,269	11.7	171
1968	20.1	40.0	3,255	12.3	163
1969	21.0	42.5	3,793	11.2	179
1970	21.4	42.5	3,976	10.7	187
1971	19.1	37.6	3,925	9.6	208
1972 [e]	22.0	46.0	4,122	11.2	179

[e] Estimate.
[1] At primary aluminum plants only.
[2] U.S. Bureau of the Census. U.S. Census of Manufactures, 1954, 1958, 1963, and 1967. U.S. Government Printing Office, Washington, D.C. The figures for 1950–53, 1955–57, 1959–62, 1964–66, and 1968–71 represent estimates derived from a representative sample of manufacturing establishments canvassed in the Annual Survey of Manufactures.

minum metal and chlorine. The chlorine is recycled. The process reportedly operates at lower temperatures than present cells, which are based on a fluoride-containing bath, and uses 30% less electrical energy, lower labor input, and less space. The new process also eliminates the need to contain fluoride emissions. A 15,000-ton-per-year facility to determine the commercial potential of the new process was scheduled for operation in 1975.

The Bureau of Mines continued investigations of methods to recover aluminum from domestic nonbauxitic ores as an alternative to importing bauxite or alumina. Previous work had demonstrated the feasibility of producing aluminum-silicon alloys by smelting domestic aluminum silicate materials such as clay or anorthosite. In recent studies high-quality aluminum metal was produced from six aluminum silicon alloys, containing 20% to 87% aluminum, by electrolysis of the alloy in a molten bath of sodium, potassium, and aluminum chlorides, with or without fluorine.[12] Recovey of aluminum exceeded 80%, and metallurgical-grade silicon was found to be recoverable as a byproduct from the alloys containing 50% to 65% aluminum.

Soviet technology for producing primary aluminum metal and for casting aluminum ingots reportedly was purchased by three large international aluminum companies during 1972. Alcan Aluminium Ltd. (Alcan), licensed a process, presumably concerned with the utilization of electrical energy, which it said could significantly increase production efficiency at its facilities in Canada.[13] Reynolds Metals Co. and Kaiser Aluminum & Chemical Corp. obtained licenses to an electromagnetic process for casting large aluminum ingots which was said to produce a smooth finish on the ingot surface and eliminate the need for scalping or trimming the ingots before they are rolled into sheet or plate or extruded. The process also was believed to produce a better quality grain structure and reduce costs by as much as 1 cent per pound.[14]

In recent years the Bureau of Mines has greatly accelerated its investigations of methods to recover aluminum and other metals and materials from solid wastes.

[12] Singleton, E. L., R. L. de Beauchamp, and T. A. Sullivan. Recovery of Aluminum From Aluminum-Silicon Alloys. BuMines RI 7603, 1972, 12 pp.
[13] Metal Bulletin. Alcan Buys Russian Process. No. 5709, June 20, 1972, p. 14.
[14] Wall Street Journal. Reynolds Metals Sees Soviet Process in Use as Early as This Fall. V. 180, No. 40, Aug. 28, 1972, p. 11.

Two molten salt electrorefining processes to recover aluminum and to concentrate other metals into a recoverable form from electronic scrap were reported.[15]

Bureau research on recovery of values from municipal incinerator residues has progressed through the pilot plant stage. The methods developed will be further tested in a $3.2 million demonstration facility scheduled for completion in 1973 at Lowell, Mass. This plant was expected to treat 65,000 tons of residue per year and recover 1,000 tons of aluminum, 700 tons of zinc and copper, and 13,500 tons of colorless glass, annually. In 1972, the major Bureau effort was shifted to the development of new methods to mechanically separate aluminum and other metals and valuable materials from raw, unburned refuse. Research on this project was on a 5-ton-per-hour stage and included such operations as shredding, air classification, magnetic separation, screening, optical sorting, and high-tension electrostatic separation.

An experimental method was developed to recover aluminum and other materials from the nonmagnetic residue resulting when wrecked automobiles are shredded, passed over a magnetic separator, and hand sorted to remove large chunks of aluminum and other nonferrous metals. In commercial practice the nonmagnetic residue, which contains about 76 pounds of aluminum metal per ton and represents an annual loss of about 700,000 tons of aluminum and other metals valued at almost $40 million, is discarded. In the new method, a mixed metal concentrate containing 95% of the metals in the original reject material is recovered in a product that is 75% metal. This product is then washed with water to obtain a product that contains 99% metal. Separation of the aluminum and other nonferrous metals in this product was being investigated using cryogenic and heavy-media separation techniques.

The principal aluminum alloys produced, the raw materials used, and the problems and processes associated with the industrial recovery of aluminum from scrap were described in a comprehensive report.[16]

The technology and economics of controlling air emissions of gas and particulates from primary and secondary aluminum production operations continued to receive attention. A comprehensive study of air emission control technology and costs in the aluminum industry in the United States was prepared under contract to the EPA by Singmaster & Bryer, Metallurgical Engineers. Results of the study were summarized by an EPA official.[17] Based on an analysis of models representing the various plant processes and control systems in use in the aluminum industry, the contractor concluded that in 1970 overall fluorine control efficiency ranged from zero at plants without controls to an average of 94.7% at plants that utilized efficient systems to control fluorine emissions from potrooms as well as from the individual reduction cells. The average fluorine control efficiency in the industry was 73%, indicacting that about 23,500 tons of fluorine or 12 pounds per ton of aluminum produced in 1970 was emitted into the air. Of the total fluorine emitted, 46% was in a gaseous state, and the remainder was in a solid form.

The fluorine and dust control system installed at an alumina reduction plant at Lista in southern Norway was described.[18] The plant, which is 50% owned by Alcoa, utilized a duplex system whereby gas and particulate material, emitted from the reduction cells, are burned to oxidize the tar content and are then passed through single-stage cyclones to remove 30% of the dust in a fraction that contains most of the iron. The remaining gas and solids are passed through a fluidized bed of alumina which entraps 98.2% of the solids and absorbs 99.9% of the fluorine. The alumina, containing absorbed fluorine and entrained dust, is fed directly to the reduction cell. The potroom gas and dust that escape from the reduction cells during servicing operations are treated in wood scrubbing towers using sea water. This system re-

[15] Sullivan, T. A., R. L. de Beauchamp, and E. L. Singleton. Recovery of Aluminum, Base, and Precious Metals From Electronic Scrap BuMines RI 7617, 1972, 16 pp.

[16] Ginsburg, T. H. Scrap Utilization By Secondary Aluminum Smelters. Proceedings of the Third Mineral Waste Symposium (jointly sponsored by the Bureau of Mines and IIT Research Institute), Chicago, Ill., Mar. 14–16, 1972, pp. 269–273.

[17] Iversen, R. E. Air Pollution in the Aluminum Industry. J. Metals. v. 25, No. 1, January 1973, pp. 19–23.

[18] Eftestol, T., E. Morkesdal, and A. K. Syrdal. Duplex Gas Cleaning System at a Modern VS Soderberg Plant. Light Metal Age, v. 30, No. 5–6, June 1972, pp. 10–14.

moved about 90% of the fluorine from the potroom gas and 50% to 60% of the dust. Total emission of fluorine from another plant with similar control systems was 3 kilograms per hour, or about 1 pound per short ton of aluminum produced, based on a 30,000-ton-per-year output rate.

One of the principal environmental concerns in the aluminum industry has been the prevention of air and water pollution from the chlorine used to flush oxides and gases from molten aluminum and to remove magnesium from aluminum-base scrap. The magnesium content of such scrap averages about 0.5% and must be reduced to about 0.1% for most casting applications. The historical method of removing gas from aluminum and magnesium from aluminum-base scrap (aside from diluting the magnesium-containing scrap with pure aluminum) has been to bubble chlorine gas up through the molten aluminum. The chlorine reacts with and flushes out various gases and also reacts with the magnesium. The resulting magnesium chloride rises to the surface of the melt where it can be skimmed off along with other products of the fluxing operation. Only about 5% to 10% of the chlorine reacts using this method, and the remainder is usually exhausted to the atmosphere. Several new methods for degassing molten aluminum alloys and for removing magnesium were developed which reportedly reduced the quantity of chlorine emitted into the air.

Reynolds Metals Co. used a mixture of gases containing 80% nitrogen and 10% each of carbon monoxide and chlorine to flush impurities from molten aluminum.[19] Another firm offered two methods to reduce chlorine pollution in fluxing molten aluminum.[20] One method utilized hexachlorethane tablets as a source of chlorine, and another utilized a mixture of a gas with 90% nitrogen and 10% chlorine.

In another process for cleaning liquid aluminum, the molten metal is treated with nitrogen gas in a degassing chamber and is then passed through a bed of coarse refractory granules, coated with flux to complete the cleaning operation, and finally passed through a bed of uncoated coarse granules to remove entrapped flux.[21] The process was said to eliminate the need for treating fumes in casting shops and to reduce operating costs, processing times, and metal losses from dross formation.

Alcoa developed a process whereby the magnesium in aluminium-base scrap is reacted with chlorine in stages in a closed system. The company reported that the stoichiometric reaction produced a 99% pure magnesium chloride as a byproduct.[22] Investment costs for processing 12,000 tons of aluminum alloy scrap per year using this method were estimated at $75,000.

Suggestions for selecting refractories and designing and constructing aluminum melting furnaces were given in a report.[23] The use of high-alumina refractories was recommended for use with molten aluminum furnaces to reduce silica migration, which increases wetting of and buildup on the furnace lining and reduces furnace volume.

The continuous hot dip method for applying an aluminum coating on steel to improve its corrosion and heat resistance has been in commercial use for many years, and in 1972 only one other process was in use on a large commercial scale. That method involved the electrostatic deposition of dry aluminum powder and was employed by the British Steel Corp. at Shotton in the United Kingdom. The hot dip process involves passing the steel strip through a molten aluminum bath at about 700° C. Formation of an iron-aluminum alloy at the interface of the steel base and the aluminum coating in this process adversely affects the formability of the material and limits its application. The dry powder process was envisaged as a means of avoiding this problem and a number of such methods were being developed.[24]

[19] Chemical Engineering. Aluminum Firm Develops Pollution Process. V. 79, No. 6, Mar. 20, 1972, p. 57.

[20] American Metal Market. Aluminum Users of Chlorine Offered Cost Cutting Methods. V. 79, No. 158, Aug. 30, 1972, p. 13.

[21] Brant, M. V., D. C. Bone, and E. F. Emley. Fumeless In-Line Degassing and Cleaning of Liquid Aluminum. J. Metals, v. 23, No. 3, March 1972, pp. 48–53.

[22] Regan, B. Alcoa Develops New Process For Recycling Aluminum Cans. Am. Metal Market, v. 79, No. 148, Aug. 15, 1972, p. 10.

[23] Jones, P. E. How To Select Refractories For Aluminum Melting Furnaces. Mod. Metals, v. 28, No. 8, September 1972, pp. 72–76.

[24] Hudson, David. Precoated Steel: 1 Aluminized Steel Sheet. Metal Bulletin Monthly, No. 19, July 1972, pp. 9–14.

Iron Age. A Third Coated Steel Is Ready To Roll. V. 209, No. 22, June 1, 1972, pp. 52–54.

Metal Bulletin. Nisshin's New Process. No. 5664, Jan. 7, 1972, p. 28.

Antimony

By Charlie Wyche [1]

In 1972, domestic mine production of antimony, curtailed by a tragic fire at the Sunshine Mine, declined to the lowest level in more than 30 years. Secondary production also continued the downward trend from the 1969 high. The 18% increase in consumption of primary antimony, however, was supplied by a 75% increase in imports of ore, metal, and oxide.

The price of RMM brand antimony metal, in bulk, f.o.b. Laredo, Tex., was stable at 57 cents per pound throughout the year. The free world antimony price edged upward following buying interest from both consumers and dealers, and the People's Republic of China's reluctance to sell. The quoted price range of European lump ore, 60% antimony, declined during the first half of 1972 but reversed the trend in the second half and showed substantial strength at yearend.

Legislation and Government Programs.—Effective January 1, 1972, the General Modification of Tariff Schedules of the United States, Federal Register document 67–14749, filed on December 18, 1967 (Federal Register, v. 32, No. 244, Dec. 19, 1967, pp. 19002–19004, reduced the import duty on antimony metal TSUS No. 632.02 from 1.2 to 1.0 cents per pound. No further reduction is scheduled.

Under authorization of Public Law 92–105, enacted August 11, 1971, the General Services Administration (GSA) disposed of 70 tons of antimony from the Government stockpile in 1972. The total quantity authorized for disposal is 6,000 tons of "C" and "D" grades metal with a maximum of 800 tons to be sold each calendar quarter. All of the antimony was restricted to domestic consumption. Sales of the metal were in the form of granules, pigs, slabs, cakes, ingots, and broken pieces. All sales were made on an "as-is" basis and in keeping with its policy in stockpile sales, no warranties were made by GSA as to the chemical analysis, physical condition, or fitness for any use or purpose of the metal. Total Government inventory at the close of the year was 46,676 tons, of which 5,976 tons were surplus.

[1] Physical scientist, Division of Nonferrous Metals.

Table 1.—Salient antimony statistics

(Short tons)

	1968	1969	1970	1971	1972
United States:					
Production:					
Primary:					
Mine	856	938	1,130	1,025	489
Smelter [1]	12,489	13,203	13,381	11,374	13,344
Secondary	23,699	23,840	21,424	20,917	22,500
Exports of ore, metal and alloys	109	207	543	1,023	121
Imports, general (antimony content)	17,343	17,032	18,654	13,595	23,743
Consumption [1]	18,520	17,843	13,937	13,707	16,124
Price: New York, average cents per pound	45.75	57.57	144.19	71.18	59.00
World: Production	67,628	73,001	77,124	70,891	75,035

[1] Includes primary antimony content of antimonial lead produced at primary lead refineries.

DOMESTIC PRODUCTION

MINE PRODUCTION

Domestic mine production from antimony ores and concentrates and coproduct antimony concentrates from silver mine production declined 52% to 489 short tons, the lowest level since 1953. Lead silver ores of the Coeur d'Alene district of Idaho contributed 345 tons, substantially below the 854 tons supplied in 1971. The drastic decline in production was due primarily to the 8-month closing of the Sunshine Mining Co., the only major domestic producer of antimony, following a disastrous fire in May. Tetrahedrite concentrates from Sunshine Mining Co., Hecla Mining Co., and Silver Dollar Mining Co. were processed into cathode metal, 96% antimony, at the Sunshine Mining Co. electrolytic plant. Byproduct antimony recovered at primary lead smelters from domestic lead ores totaled 516 tons. Most of this antimony was not recovered as the pure metal, but was processed to and consumed as antimonial lead.

The U.S. Antimony Corp. became a fully integrated mining, milling, refining, and sales organization. The company successfully completed a refining procedure to convert antimony sulfide concentrates to metallic antimony. Approximately 142 tons of antimony was produced in 1972, using this pollution-free process. In Nevada, one mine produced a small tonnage of antimony ore.

Table 2.—Antimony mine production and shipments in the United States

(Short tons)

Year	Antimony concentrate (Quantity)	Antimony Produced	Antimony Shipped
1968	5,263	856	941
1969	5,707	938	943
1970	6,681	1,130	1,029
1971	4,721	1,025	1,073
1972	2,072	489	547

SMELTER PRODUCTION

Primary.—Production of 13,344 tons of antimony from primary ores at domestic smelters represented a 17% increase above that of 1971. The increase was essentially in production of oxide, and sulfide compounds, as metal production increased only slightly above that of 1971. Byproduct antimonial lead output dropped to 731 tons, 35% below that of the previous year. The source of feed materials for the smelter was as follows: 92% from foreign antimony ores and base metal ores, and 8% from domestic mine production of antimony concentrate and as byproduct at domestic lead smelters. Antimony recovered as a lead-smelter byproduct represented 7% of the total primary antimony production. Over 90% of the byproduct antimony produced at primary lead smelters was consumed at the smelter in manufacturing antimonial lead. A small quantity was processed to oxide or recycled in residues.

Primary smelter products were divided as follows: Metal, 29%; oxide, 63%; antimonial lead, 5%; and sulfide and residues, 3%. The NL Industries, Inc., smelter at Laredo, Tex., and the Sunshine Mining Co. electrolytic plant at Big Creek, Idaho, produced antimony metal. Oxide was produced by American Smelting and Refining Co., McGean Chemical Co., Harshaw Chemical Co., M & T Chemicals Inc., and NL Industries. Bunker Hill Co., American Smelting and Refining Co., St. Joe Minerals Corp., and U.S. Smelting Lead Refinery, Inc., were the principal producers of byproduct antimonial lead. McGean Chemical Co., Hummel Chemical Co., and M & T Chemicals Inc. produced antimony sulfide.

Secondary.—Secondary antimony recovery, from lead scrap, was slightly higher than in 1971. The increase was due chiefly to secondary lead plants as recoveries at primary lead smelters increased to about 61 tons. Manufacturers and foundries recovered 902 tons of antimony in processing scrap, 194 tons more than in 1971. Sources of old scrap, which supplied 85% of the secondary antimony, consisted of the following: Batteries, 70%; type metal, 17%; babbitt, 5%; and miscellaneous material, 8%. Drosses and residues resulting from manufacturing and casting operations provided 3,400 tons, or 15% of the total secondary antimony. Antimony in scrap is usually recovered as antimonial lead, with additions or removal of antimony as required in the refining stage to meet specifications for the various antimonial lead alloys. About 2,570 tons of primary antimony was used by secondary smelters to supplement the secondary supply during 1972, compared with 2,850 tons in 1971.

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	
1968	3,617	6,518	133	417	1,804	12,489
1969	3,129	7,746	95	330	1,903	13,203
1970	3,732	8,261	23	384	981	13,381
1971	3,816	6,272	18	136	1,132	11,374
1972	3,837	8,343	232	201	731	13,344

Table 4.—Secondary antimony produced in the United States, by kind of scrap and form of recovery

(Short tons, antimony content)

Kind of scrap	1971	1972	Form of recovery	1971	1972
New scrap:			In antimonial lead [1]	15,839	17,200
Lead-base	3,269	3,100	In other lead alloys	5,067	5,280
Tin-base	73	300	In tin-base alloys	11	20
Total	3,342	3,400	Total	20,917	22,500
Old scrap:			Value (millions)	$29.8	$70.2
Lead-base	17,550	19,000			
Tin-base	25	100			
Total	17,575	19,100			
Grand total	20,917	22,500			

[1] Includes 59 tons of antimony recovered in antimonial lead from secondary sources at primary plants in 1971 and 120 tons in 1972.

Table 5.—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	Total %
1968	28,363	1,300	504	203	2,007	7.1
1969	24,741	1,174	729	179	2,082	8.4
1970	20,438	598	383	203	1,184	5.8
1971	19,686	828	304	59	1,191	6.0
1972	15,051	516	215	319	1,050	7.0

[1] Includes primary residues and a small quantity of antimony ore.
[2] Includes foreign base bullion and small quantities of foreign antimony ore.

CONSUMPTION AND USES

Industrial consumption of antimony in various end products totaled 38,624 tons, an increase of 12% above that of 1971. Primary antimony contributed 16,124 tons, 42% of the total, and secondary antimony, 22,500 tons. Secondary antimony was used predominantly in the manufacture of antimonial lead and other hard-lead alloys.

Consumption of primary antimony increased 18% in comparison to that of the previous year. Consumption increased for all classes of material consumed except byproduct antimonial lead. Antimony metal and antimony oxide represented 34 and 52%, respectively, of the material consumed, and antimonial lead about 5%. Consumption of primary antimony in metal products increased 11%, principally in that used for antimonial lead. Increases were reported for all products except ammunition, cable covering, solder, and type metal.

Nonmetal products required 23% more antimony in 1972 than in 1971. One of the largest uses was in flameproofing chemicals and compounds. Demand for flame-retardant materials increased when the U.S. Department of Transportation safety standard went into effect. This standard established specific flammability restrictions for interior components of passenger cars, trucks, and buses. In order to meet this requirement, automotive companies added various flame-retardant materials to their 1973 model interiors. Consumption in plastics, rubber products, and pigments also continued the upward trend. A total of 1,118 tons of antimony was consumed in "Other" nonmetal products. Three compounds, antimony sulfide, and potassium pyro-antimonate, with a wide range of applications, and sodium antimonate predominantly an opacifying agent in enamel and glass, accounted for 54% of the total. Approximately 19% was consumed as antimony chloride (pentachloride and trichloride), and the remaining 27% was used in a variety of chemical compounds.

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
1968	299	6,561	9,363	75	418	1,804	18,520
1969	507	6,275	8,756	72	330	1,903	17,843
1970	380	4,989	7,157	46	384	981	13,937
1971	387	5,080	6,944	28	136	1,132	13,707
1972	1,226	5,473	8,389	104	201	731	16,124

Table 7.—Industrial consumption of primary antimony in the United States, by class of material produced

(Short tons, antimony content)

Product	1968	1969	1970	1971	1972
METAL PRODUCTS					
Ammunition	156	115	102	67	64
Antimonial lead	6,817	6,723	5,246	5,430	6,149
Bearing metal and bearings	755	758	481	515	559
Cable covering	178	55	38	36	19
Castings	46	33	16	20	39
Collapsible tubes and foil	50	56	35	22	20
Sheet and pipe	105	105	77	74	108
Solder	255	242	286	178	177
Type metal	423	541	220	177	142
Other	258	137	73	102	105
Total	9,043	8,765	6,574	6,621	7,382
NONMETAL PRODUCTS					
Ammunition primers	33	37	27	23	23
Fireworks	37	30	17	4	4
Flameproofing chemicals and compounds	2,774	2,096	1,774	1,524	2,280
Ceramics and glass	2,037	2,108	1,820	1,840	1,695
Pigments	859	722	610	592	644
Plastics	2,318	2,558	1,667	1,810	2,391
Rubber products	440	433	519	525	587
Other	979	1,094	929	768	1,118
Total	9,477	9,078	7,363	7,086	8,742
Grand total	18,520	17,843	13,937	13,707	16,124

STOCKS

Industrial stocks of primary antimony declined from the 9,740 tons at the end of the first quarter to a low of 8,481 tons at the end of the second quarter, increased to 9,130 tons by the end of the third quarter, and totaled 8,622 tons at yearend. Increases in oxide and sulfide stocks failed to offset decreases in metal, residues, antimonial lead, and ore and concentrates. Government stocks of antimony metal totaled 46,676 tons at the close of 1971. Of the total inventory, the strategic stockpile contained 24,645 tons and the supplemental stockpile contained 22,031 tons.

Table 8.—Industry stocks of primary antimony in the United States, December 31
(Short tons, antimony content)

Stocks	1968	1969	1970	1971	1972
Ore and concentrate	2,791	2,227	2,973	3,582	3,562
Metal	1,323	1,273	1,598	1,367	1,332
Oxide	1,921	2,053	2,932	2,697	3,179
Sulfide	127	108	39	22	182
Residues and slags	199	307	948	647	176
Antimonial lead [1]	265	371	357	322	191
Total	6,626	6,339	8,847	8,637	8,622

[1] Inventories from primary sources at primary lead refineries only.

PRICES

The domestic price of antimony metal, 99.5%, RMM brand, and 99.8%, "Lone Star" brand, held at 57 and 68 cents per pound, respectively, in bulk, f.o.b., Laredo, Tex., (59 and 70 cents at New York). The dealer price for imported metal, duty paid, New York, also continued at 60 cents per pound. The domestic price of oxide continued unchanged at 69 cents per pound in carload lots.

At the beginning of the year, the quoted price of European lump ore, 60% contained antimony, at New York was $8.64 to $10 per short-ton unit. The price began to decrease in February due to lack of demand resulting from a slowdown in the U.S. economy. From February to August quotations were 25 to 30 cents per short-ton unit lower than earlier in the year. Prices eased in the second quarter and at yearend the quotation ranged from $7.60 to $8.60 per short-ton unit.

The GSA quoted prices for "C" (99.0%) and "D" (97.6%) metal were 54 and 51.5 cents per pound, respectively, f.o.b., designated Government storage locations.

Table 9.—Antimony price ranges in 1972

Type of antimony	Price per pound
Domestic metal [1]	$0.57
Foreign metal [2]	.535–0.57
Antimony trioxide [3]	.69–.77

[1] RMM brand, f.o.b., Laredo, Tex.
[2] Duty-paid delivery, New York.
[3] Quoted in Metals Week.

FOREIGN TRADE

Exports of antimony in alloys, metal, scrap, and waste totaled 121 tons and were valued at $84,800, only one-tenth the value of exports in 1971. Exports were destined for 12 countries. Canada, France, the United Kingdom, West Germany, and Chile, in declining order of receipts, accounted for 93% of the total. The quantity of antimony oxide exports increased to 311 tons valued at $276,600. Consignments were made to 15 countries. Canada imported 34% of the oxide, followed by West Germany and Taiwan with 33% and 13%, respectively. The remainder was divided among 13 other countries.

General imports of antimony of all categories totaled 23,743 tons (antimony content), a 75% increase from the 1971 deliveries and the highest level on record. The increase was essentially as antimony in ore and concentrate which increased from 22,100 to 33,500 tons gross weight. Oxide imports increased from 2,800 to 5,000 tons gross weight and metal imports from 1,700 to 2,400 tons. The Republic of South Africa and Bolivia supplied 59 and 15%, respectively, of the ore and concentrate imported. The People's Republic of China supplied almost half of the metal. The United Kingdom, Belgium-Luxembourg, and France supplied essentially all of the oxide imports (83%).

Additional imports included 129 tons of alloy containing 83% or more antimony by weight, 67% of which came from Mexico; 31 tons was received from United Kingdom; and 11 tons was supplied by Taiwan. Total value of this material was $136,314.

Table 10.—U.S. imports for consumption of antimony, by country

Country	1971			1972		
	Short tons (gross weight)	Short tons (antimony content)	Value (thousands)	Short tons (gross weight)	Short tons (antimony content)	Value (thousands)
Antimony ore:						
Australia	54	36	$41	56	34	$19
Bolivia	2,610	1,593	2,131	4,071	2,562	1,536
Canada	22	10	9	--	--	--
Chile	489	311	537	2,759	1,722	1,096
Germany, West	--	--	--	57	25	15
Guatemala	1,230	615	134	315	158	35
Honduras	296	118	44	77	19	6
Mexico	9,540	2,314	847	8,261	2,217	820
Morocco	229	103	63	365	150	70
Mozambique	679	402	478	--	--	--
Peru	69	34	16	44	27	19
South Africa, Republic of	6,400	3,826	4,273	17,224	10,160	5,766
Thailand	143	92	100	313	138	55
United Kingdom	341	165	114	--	--	--
Total	22,102	9,619	8,787	33,542	17,212	9,437
Antimony metal including needle or liquated:[1]						
Belgium-Luxembourg	175	--	231	138	--	135
Bolivia	10	--	9	--	--	--
Brazil	--	--	--	55	--	50
Canada	(2)	--	26	1	--	15
China, People's Republic of	16	--	17	1,017	--	973
Czechoslovakia	2	--	2	--	--	--
France	65	--	87	59	--	64
Germany, West	11	--	14	(2)	--	8
Hong Kong	--	--	--	66	--	65
Italy	17	--	18	--	--	--
Japan	649	--	796	86	--	103
Malaysia, Republic of	17	--	17	--	--	--
Mexico	233	--	149	362	--	194
Netherlands	11	--	7	22	--	23
Singapore	--	--	--	5	--	5
Spain	11	--	13	12	--	13
Taiwan	63	--	68	106	--	101
Thailand	77	--	101	--	--	--
Turkey	32	--	28	37	--	30
United Kingdom	88	--	136	160	--	142
Yugoslavia	193	--	242	254	--	246
Total	1,670	(3)	1,961	2,380	(3)	2,167
Antimony oxide:						
Belgium-Luxembourg	439	--	569	610	--	651
Canada	1	--	1	--	--	--
China, People's Republic of	--	--	--	85	--	79
France	692	--	1,047	1,359	--	1,502
Germany, West	50	--	59	172	--	186
Japan	330	--	552	556	--	633
Netherlands	47	--	66	52	--	62
United Kingdom	1,232	--	2,023	2,198	--	2,653
Total	2,791	(3)	4,317	5,032	(3)	5,766

[1] Includes needle or liquated (value in thousands): 1971—Belgium-Luxembourg, 32 tons ($47); 1972—Belgium-Luxembourg, 73 tons ($68); United Kingdom, 5 tons ($7).
[2] Less than ½ unit.
[3] Content not reported.

Table 11.—U.S. imports for consumption of antimony

Year	Antimony ore			Needle or liquated		Antimony metal[1]		Antimony oxide	
	Short tons (gross weight)	Antimony content: Short tons	Antimony content: Value (thousands)	Short tons (gross weight)	Value (thousands)	Short tons (gross weight)	Value (thousands)	Short tons (gross weight)	Value (thousands)
1970	34,415	13,820	$12,733	18	$54	1,290	$3,493	4,256	$10,023
1971	22,102	9,619	8,787	32	47	1,638	1,914	2,791	4,317
1972	33,542	17,212	9,437	78	75	2,302	2,092	5,032	5,766

[1] Does not include alloy containing 83% or more of antimony; 1970—United Kingdom, 179 short tons ($378,740); Turkey, 18 short tons ($50,411); Japan, 13 short tons ($31,346); 1971—United Kingdom, 120 short tons ($120,093); Turkey, 32 short tons ($29,022); Japan, 22 short tons ($18,453); Mexico, 85 short tons ($113,319); Thailand, 11 short tons ($10,356); 1972—Mexico, 87 short tons ($79,294); United Kingdom, 31 short tons ($25,327) ;Taiwan, 11 short tons ($31,693).

WORLD REVIEW

World production in 1972 increased about 5,000 tons to a high of more than 75,000 tons. The most significant increase was in Thailand, which gained about 3,000 tons compared with 1971 production. Production increases were also reported in Mexico and Bolivia, which more than compensated for declines in output from the United States, Peru, Morocco, and Honduras.

The market was weak and demand was at a low level when the year began. A firming trend in world antimony prices began developing in midyear, and this trend continued throughout the remainder of 1972. The antimony industry was optimistic, based mainly on the use of antimony oxide for flame retardancy in the vinyl plastic field, especially in automotive applications. As a result, antimony producers around the world continued to develop new mines and to expand existing ones.

Table 12.—Antimony: World production (content of ore except where otherwise indicated) by country

(Short tons)

Country	1970	1971	1972 p
North America:			
Canada [1]	363	162	235
Guatemala	r 1,430	976	e 1,000
Honduras	378	160	33
Mexico [2]	4,925	3,705	e 4,700
United States	1,130	1,025	489
South America:			
Argentina	--	15	e 15
Bolivia [3]	12,970	12,861	14,472
Peru (recoverable) [2]	r 1,286	1,127	382
Europe:			
Austria (recoverable)	672	515	e 530
Czechoslovakia e	660	660	660
Italy	1,432	1,295	e 1,300
Portugal	[4] --	[4] --	11
Spain	r 87	122	150
U.S.S.R. e	7,400	7,600	7,700
Yugoslavia	3,197	3,204	3,171
Africa:			
Algeria	66	e r 66	e 66
Morocco	r 2,008	2,174	929
South Africa, Republic of	19,147	15,704	16,062
Asia:			
Burma	72	141	144
China, People's Republic of e	13,000	13,000	13,000
Japan	7	3	e 6
Korea, Republic of	--	--	3
Malaysia (Sarawak)	198	317	226
Pakistan e	33	34	50
Thailand	2,598	2,529	5,234
Turkey	3,053	2,435	e 2,500
Oceania: Australia [5]	r 1,012	1,061	1,467
Total	r 77,124	70,891	75,035

e Estimate. p Preliminary. r Revised.
[1] Antimony content of smelter products.
[2] Includes antimony content of antimonial lead.
[3] Data for 1970 are the sum of exports by small and medium mines and COMIBOL output; data for 1971 and 1972 reportedly represent total exports.
[4] 1970 and 1971 revised to zero.
[5] Antimony content of antimony concentrates, lead concentrates and lead-zinc concentrates.

Australia's Antimony Corp. N.L. placed the Dorrigo antimony mine in New South Wales on a production basis in view of the increased world market price of antimony concentrate. The company anticipates that prices will continue to firm as a result of projected improvement in the world economy, particularly in the United States. Production plans are for an output of about 4,000 tons per year of antimony concentrate representing gross annual sales of $2 million at the 1972 price level.

Munga Creek Minerals reported further work on the main shaft at the Munga Creek antimony mine at Kempsil, New South Wales. Following sublevel development, stoping was in progress, and a continuous supply of good ore has been assured. In the fourth quarter of 1972, the company produced 9,500 tons of antimony concentrate. Mill capacity will be doubled as soon as the main shaft comes into production.

An antimony plant came on stream in Italy. Azienda Minerali Metallici Italiani S.p.A. (AMMI) began operating its mine and metallurgical plant, at Manciano, near Grosseto. The antimony deposit contains an estimated metal reserve of 20,000 tons. Initial capacity of the plant has been scheduled at about 150 tons per year of metallic antimony.

In the Republic of South Africa at Consolidated Murchison Goldfields and Development Co. Ltd.'s plant, 547,000 tons of ore were milled during 1972, yielding 24,400 tons of antimony concentrate and cobbed ore. Although this output represented a 10% increase in the milling rate compared with that of 1971, the production of concentrate increased only marginally as the grade of ore mined was lower. To overcome this possible limiting condition on metal production, a decision was made in September to locate a new shaft, to be known as the Athens shaft, at the Weigel ore body. This ore body, which was mined and treated successfully at fairly shallow depths in the past, was selected in preference to the New Monarch ore body where preliminary work showed it to be more irregular. Working costs per ton milled were reduced by 12% compared with those of 1971. The increased milling rate could result in insufficient ore being available from the Alpha section of the mine by 1975.

In Bolivia, contracts for the structural steel to be used in the construction of the buildings housing a new antimony smelter were signed. Construction of the smelter is expected to be completed in 1975, with an estimated annual input capacity of 13,200 short tons of antimony concentrate averaging 60% antimony. This input quantity will result in a total annual output of close to 7,200 tons of antimony in the form of antimony trioxide. The patented process, developed in Czechoslovakia, to be used in the smelter is a system of volatilization and reduction of the antimony sulfide concentrate.

In 1972, Consolidated Durham Mines and Resources Limited began production at its Lake George area antimony property near Fredericton, New Brunswick, Canada. The mill has a capacity in excess of 400 tons per day; however, during 1972 production was maintained at 125 to 150 tons per day. Ore reserves at the 318-claim Durham Property were estimated at 150,000 tons, averaging 7% stibnite in two parallel veins.

TECHNOLOGY

One United States patent relating to the electrowinning of antimony from stibnite was issued during the year. U.S. patent 3,657,081, issued to W. C. Holmes on April 18, 1972, described a process in which concentrated stibnite ore is leached with a solution of sodium sulfide. The leached solution is electrolyzed in a diaphragm cell using the leach solution as the catholyte and stripped catholyte as the anolyte. A portion of the resulting oxidized anolyte is treated with chlorine gas to precipitate antimony and sulfur; the antimony precipitate is returned to the leaching circuit; and sufficient sulfur is discarded to maintain the sulfide sulfur concentration of the leaching solution at a predetermined level.

The results of the investigation of the metastable phases in liquid-quenched alloys of chromium and manganese with antimony,[2] and the transport and thermoelectric properties of compacts of bismuth and Bi–12 atomic percent antimony alloy powder were reported.[3]

Another important technical development during the year included a process for removal of surface antimony from antimony lead alloys by sulfuric acid-hydrogen peroxide pickling.[4] The surface antimony results from positive battery plates releasing a large proportion of their surface antimony during plate formation.

A recent development in the use of antimony with silver has produced a new brightening solution that adds hardness, exceptional brightness, and tarnish resistance in silver plating.[5] Called Techni-

[2] Speight, J. D. Metastable Phases in Liquid-Quenched Alloys of Chromium and Manganese With Antimony. Met. Trans., v. 3, No. 4, April 1972, pp. 1011–1012.

[3] Cochrane, G., and W. V. Youdelis. Transport and Thermoelectric Properties of Bismuth and Bi–12 Atomic Percent Alloy Powder Compacts. Met. Trans., v. 3, No. 11, November 1972, pp. 2843–2850.

[4] Crompton, T. R., and G. Uitenbroek. Removal of Surface Antimony From Antimony Lead Alloys by Sulfuric Acid–Hydrogen Peroxide Pickling. J. Electrochem. Soc., v. 119, No. 6, June 1972, pp. 655–660.

[5] Skillings' Mining Review. V. 62, No. 5, Feb. 3, 1973, p. 15.

Silver E, the product allows an increase in amperage in the plating bath to 20 amperes per square foot of material, about double the usual level. The increased current density produces a plated item that requires no buffing or retouching after the plating process. The treatment increases tarnish resistance to about four times the amount usually found in silver plating.

An article published in 1972 on the flotation of stibnite from some Indian ores showed that the mineral could be floated after grinding through 48 mesh.[6] It could be floated easily at low pH with a mineral oil as collector and pine oil as frother. Stibnite could also be floated effectively with xanthates, provided the pulp is preconditioned with soluble lead or copper salts.

---

[6] Vijayakuman, K., and K. K. Majumdar. Studies on the Flotation of Stibnite. J. Mines, Metals and Fuels, v. 20, No. 11, November 1972, pp. 342–346.

Asbestos

By Robert A. Clifton [1]

Shipments of asbestos in the United States increased less than 1% but established another record high in 1972. There was no readily apparent single reason that could explain the increased demand for asbestos. Imports were 8% above 1971 levels.

The world's largest producer, Canada, increased shipments to its largest market, the United States, by 10%; its total shipments were 3% over the 1971 total.

Legislation and Government Programs.—The Environmental Protection Agency (EPA) had not published its asbestos emission standards by yearend, but their latest proposal recognized the adequacy of Bureau of Mines controls in mines and mills and would only control visible emissions from mill effluent gases. In 1972 the General Services Administration (GSA) reduced government inventories by disposing of 1,040 short tons of amosite, 11,478 tons of crocidolite, and 656 tons of chrysotile. The strategic grades of asbestos formerly under the Rhodesian Sanctions began to appear again on the U.S. market.

[1] Chemist, Division of Nonmetallic Minerals.

Table 1.—Salient asbestos statistics

	1968	1969	1970	1971	1972
United States:					
Production (sales) short tons	120,690	125,936	125,314	130,882	131,663
Value thousands	$10,406	$10,648	$10,696	$12,174	$13,409
Exports and reexports (unmanufactured) short tons	41,236	36,173	46,585	53,678	58,624
Value thousands	$4,679	$4,979	$6,996	$7,863	$9,051
Exports and reexports of asbestos products (value) thousands	$24,527	$28,183	$25,391	$31,430	$32,110
Imports for consumption (unmanufactured) short tons	737,909	694,558	649,402	681,367	735,515
Value thousands	$72,930	$76,422	$75,146	$80,090	$87,732
Consumption, apparent [1] short tons	817,363	784,321	728,131	758,571	808,554
World: Production do	3,315,301	3,599,123	3,851,251	3,951,373	4,083,340

[1] Measured by quantity produced, plus imports, minus exports.

Table 2.—Stockpile objective and Government inventories as of October 31, 1972

(Short tons)

Mineral	Stockpile objective	Inventories			
		National	Supplemental	Defense Production Act	Total
Amosite	18,400	11,705	46,893	--	58,598
Chrysotile	13,700	6,079	5,916	242	12,237
Subspecification	--	20	1,032	242	1,294
Crocidolite	None	1,554	23,890	--	25,444

Environmental Impact.—The expected effects of environmental regulations on the asbestos market were not apparent in 1972. The effect may just be postponed, because the Office of Safety and Health Administration (OSHA) of the Department of Labor did not promulgate its regulations until June 7, 1972, and EPA had not promulgated its regulation by yearend. The OSHA Threshold Limit Value (TLV) retained its previous emergency value of five fibers greater than 5 micrometers in length per milliliter. The five fiber TLV is scheduled for reduction to two fibers in 1976. This schedule might be shortened if union and activist pressures continue.

The final prepublication proposals for EPA regulations differed greatly from the originals as far as asbestos mining was concerned. The mines were omitted entirely as not needing EPA regulation, and the only standard applicable to mills pertained to "visible emissions to the outside air."

Some States, having written acceptable regulations, are now the environmental control regulating agency, with their regulations superseding, at least partially, those of the Bureau of Mines, OSHA and EPA.

DOMESTIC PRODUCTION

U.S. mines shipped less than 1% more asbestos in 1972 than in 1971. The value increased 10%. Four States produced asbestos; California, with 69%, was the leader, followed in order by Vermont, Arizona, and North Carolina.

The California segment of the asbestos industry continued to grow, with a 4% increase in production to 90,967 tons, and was led by the Pacific Asbestos Corp. mine in Calaveras County. The largest producing County was Fresno, with the Coalinga Asbestos Co., Inc., and Atlas Asbestos Corp. mines. Union Carbide Corp. had significant production in San Benito County. The State's increased production realized an $867,229 increase in value.

The GAF Corp. mine in Orleans County, Vt., remained the U.S. asbestos mine with the highest production and highest product value. With only the Jaquays Mining Corp. mine in Gila County operating again in 1972, Arizona production increased 2%. The production in North Carolina of Powhatan Mining Co. declined another 14% in 1972. U.S. asbestos producers and mine sites are as follows:

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.
Coalinga Asbestos Co., Inc	do	Christie	Do.
Pacific Asbestos Corp	Calaveras	Pacific Asbestos	Do.
Union Carbide Corp	San Benito	Santa Rita	Do.
North Carolina:			
Powhatan Mining Co	Yancey	Hippy	Anthophyllite.
Do	Jackson	Boot Hill	Do.
Vermont: GAF Corp	Orleans	Lowell	Chrysotile.

Table 3.—Asbestos production and consumption

Year	Number of mines	Production: Quantity (short tons)	Production: Value	Production: Unit value	Imports: Quantity (short tons)	Imports: Value	Imports: Unit value	Imports: % of consumption	Exports (short tons)	Apparent consumption (short tons)
1873	--	--	--	--	NA	$18	NA	100	--	NA
1874	--	--	--	--	NA	152	NA	100	--	NA
1875	--	--	--	--	NA	4,706	NA	100	--	NA
1876	--	--	--	--	NA	5,485	NA	100	--	NA
1877	--	--	--	--	NA	1,671	NA	100	--	NA
1878	--	--	--	--	NA	3,536	NA	100	--	NA
1879	--	--	--	--	[1]49	3,204	[2]$65	100	--	49
1880	NA	150	$4,312	$29	[1]150	9,736	[2]65	50	--	300
1881	NA	200	7,000	35	[1]425	27,717	[2]65	68	--	626
1882	NA	1,200	36,000	30	[1]234	15,235	[2]65	16	--	1,434
1883	NA	1,000	30,000	30	[1]338	24,369	[2]72	25	--	1,338
1884	NA	1,000	30,000	30	[1]739	48,755	[2]66	42	--	1,739
1885	NA	300	9,000	30	[1]1,262	73,026	[2]58	81	--	1,562
1886	NA	200	6,000	30	[1]2,237	134,193	[2]60	92	--	2,437
1887	NA	150	4,500	30	[1]2,863	140,264	[2]49	95	--	3,013
1888	NA	100	3,000	30	[1]2,907	168,584	[2]58	97	--	3,007
1889	NA	30	1,800	60	[1]3,632	254,239	[2]70	99	--	3,662
1890	NA	71	4,560	64	[1]1,973	252,557	[2]128	97	--	2,044
1891	NA	66	3,960	60	[1]3,274	353,589	[2]108	98	--	3,340
1892	NA	104	6,416	62	[1]4,101	262,433	[2]64	98	--	4,209
1893	NA	50	2,500	50	[1]3,658	175,602	[2]48	99	--	3,708
1894	NA	325	4,463	14	[1]4,364	240,029	[2]55	88	--	4,959
1895	NA	795	13,525	17	[1]5,361	225,147	[2]42	87	--	6,156
1896	NA	504	6,100	12	[1]6,545	229,084	[2]35	93	--	7,049
1897	NA	580	6,450	11	[3]	263,640	[3]	[3]	--	[3]
1898	NA	605	10,300	17	[3]	287,636	[3]	[3]	--	[3]
1899	NA	681	11,740	17	[3]	303,119	[3]	[3]	--	[3]
1900	NA	1,054	16,310	15	[3]	331,796	[3]	[3]	--	[3]
1901	2	747	13,498	18	[3]	667,087	[3]	[3]	--	[3]
1902	2	1,005	16,200	16	[3]	729,421	[3]	[3]	--	[3]
1903	4	887	16,760	19	[3]	657,269	[3]	[3]	--	[3]
1904	3	1,480	25,740	17	[3]	700,572	[3]	[3]	--	[3]
1905	6	3,109	42,975	14	[1]26,761	776,362	[2]29	90	--	29,870
1906	6	1,695	28,565	17	[1]30,620	1,010,454	[2]33	94	--	32,315
1907	2	653	11,899	18	[1]27,603	1,104,109	[2]40	99	325	27,931
1908	2	936	19,624	21	28,114	1,068,322	[2]38	98	300	28,750
1909	4	3,085	62,603	20	27,591	993,278	[2]36	90	--	30,676
1910	4	3,693	68,357	19	53,211	1,122,085	21	94	--	56,904
1911	4	7,604	119,935	16	63,979	1,318,539	21	89	--	71,583
1912	3	4,403	87,959	20	71,523	1,456,012	20	94	--	75,926
1913	3	1,100	11,000	10	86,737	1,928,705	22	99	--	87,837
1914	5	1,247	18,965	15	71,866	1,407,758	20	98	--	73,113
1915	5	1,731	76,952	44	93,566	1,981,483	21	98	--	95,297
1916	5	1,479	448,214	303	116,162	3,303,470	28	99	--	117,641
1917	8	1,683	506,056	301	134,108	4,521,172	34	99	708	135,083
1918	6	802	121,687	152	137,700	6,337,585	46	99	697	137,805

See footnotes at end of table.

Table 3.—Asbestos production and consumption—Continued

Year	Number of mines	Production: Quantity (short tons)	Production: Value	Production: Unit value	Imports: Quantity (short tons)	Imports: Value	Imports: Unit value	Imports: % of consumption	Exports (short tons)	Apparent consumption (short tons)
1919	12	1,761	$248,265	$214	135,270	$7,369,685	$54	100	1,119	135,312
1920	14	1,648	650,311	395	167,558	9,120,253	54	98	--	170,854
1921	9	831	336,968	405	72,463	2,948,302	41	99	--	73,294
1922	8	67	10,120	151	149,427	5,144,700	34	100	376	149,118
1923	5	227	9,626	42	212,420	7,445,143	35	100	680	211,967
1924	10	300	42,526	142	183,250	5,602,945	31	100	1,270	182,280
1925	7	1,258	51,700	41	230,520	7,134,302	31	100	1,109	230,669
1926	6	1,358	134,731	99	257,621	8,142,505	32	100	1,104	257,875
1927	7	2,981	336,882	113	223,693	8,150,340	36	99	309	226,365
1928	9	2,239	351,178	157	230,595	9,017,891	39	99	850	231,984
1929	11	3,155	351,004	111	262,427	11,153,017	42	99	709	264,873
1930	8	4,242	289,284	68	208,681	7,064,824	34	98	771	212,152
1931	6	3,228	118,967	37	136,361	3,749,340	27	99	1,714	137,875
1932	6	3,559	105,292	30	96,754	2,250,200	23	98	1,707	98,606
1933	5	4,745	130,677	28	119,494	3,540,675	30	97	1,378	122,861
1934	5	5,087	158,347	31	120,334	3,377,994	28	97	1,669	123,752
1935	4	8,920	292,927	33	166,585	5,125,413	31	95	850	174,655
1936	7	11,064	314,161	28	243,602	7,524,937	31	97	3,744	250,870
1937	10	12,079	344,644	29	307,188	10,470,208	34	97	3,004	316,263
1938	6	10,440	247,264	24	179,490	6,160,602	34	96	2,780	187,150
1939	12	15,459	512,788	33	242,561	9,094,538	37	95	2,473	255,547
1940	15	20,060	674,508	34	246,613	10,034,433	41	94	4,474	262,199
1941	17	24,391	725,753	30	419,446	17,913,265	43	96	4,846	438,991
1942	11	15,481	498,857	32	419,242	21,217,650	51	97	774	433,949
1943	11	6,014	334,815	56	440,255	23,053,524	52	99	364	445,905
1944	11	6,667	380,334	57	400,956	18,552,940	46	98	475	407,148
1945	11	12,226	417,348	34	374,199	16,284,915	44	99	8,550	377,875
1946	8	14,075	504,764	36	456,688	18,731,378	41	99	11,011	459,752
1947	10	24,035	918,558	38	594,839	29,821,519	50	96	2,087	616,787
1948	17	37,092	1,806,261	49	647,881	37,974,092	59	95	6,530	678,443
1949	9	43,387	2,614,416	60	515,303	33,939,582	66	97	20,045	532,708
1950	16	42,434	2,925,050	69	705,458	47,284,205	67	97	20,890	727,002
1951	15	51,645	3,912,500	76	761,873	58,521,046	77	96	16,526	796,992
1952	13	53,864	4,713,032	87	709,419	61,595,900	87	94	10,724	752,559
1953	18	54,456	4,857,359	89	692,245	59,753,583	86	93	3,076	743,625
1954	21	47,621	4,697,962	99	678,390	55,856,606	82	94	1,894	724,117
1955	17	44,580	4,487,428	101	740,423	60,957,578	82	95	2,787	782,216
1956	13	41,312	4,742,446	115	689,034	61,829,275	90	95	2,950	727,396
1957	15	43,653	4,917,548	113	682,732	60,139,815	88	94	2,893	723,492
1958	13	43,979	5,127,000	117	644,331	58,314,000	91	94	3,026	685,284
1959	12	45,459	4,391,000	97	713,047	65,006,000	91	95	4,461	754,045
1960	14	45,223	4,231,000	94	669,495	63,345,000	95	94	5,525	709,193
1961	12	52,814	4,347,000	82	616,529	58,942,000	96	93	3,799	665,544
1962	11	53,190	4,677,000	88	676,027	64,150,000	95	93	2,949	726,268
1963	11	66,606	5,425,000	81	667,860	61,739,000	92	92	10,044	724,422

1964	12	101,092	8,143,000	81	739,361	72,973,000	99	91	27,147	813,306
1965	12	118,275	10,162,000	86	719,559	70,457,000	98	91	43,126	794,408
1966	10	125,928	11,056,000	88	726,459	73,100,000	101	90	46,996	805,391
1967	9	123,189	11,102,000	90	645,112	65,743,000	102	90	47,718	720,583
1968	9	120,690	10,406,000	86	737,909	72,930,000	99	90	41,236	817,363
1969	9	125,936	10,648,000	85	694,558	76,422,000	110	89	36,173	784,321
1970	10	125,314	10,696,000	85	649,402	75,146,000	116	89	46,585	728,131
1971	9	130,882	12,174,000	93	681,367	80,090,000	118	90	53,678	758,571
1972	8	131,663	13,409,000	102	735,515	87,732,000	119	91	58,624	808,554

NA Not available.
[1] Estimated by assigning Canadian values to all imports.
[2] Canadian shipment values.
[3] During these years Canadian production figures and values included "Asbestic" (tailings and short fibers), making extraction of an average fiber value impossible.

CONSUMPTION AND USES

In the 100th year of commercial asbestos use in the United States, some new definitive data on consumption have been collected. These data, because they were collected on a greatly revised form from an expanded list of consumers, bear no relationship to the estimates of previous years, and comparisons are inappropriate. They are shown in table 5. The chrysotile data in the table have been adjusted to reflect 95% of the apparent consumption. The other data are presented as reported.

It is no surprise that with a few thousand known end uses, 15% of consumption falls into minor categories or "Other." The eight major uses are construction 42%, floor tile 11%, friction products 10%, paper 9%, asphalt felts 6%, packing and gaskets 4%, insulation 2%, and textiles 1%.

Analysis of the newly available data on U.S. consumption of asbestos will be facilitated by some rather arbitrary combination of chrysotile grades. Table 4 shows these combinations, which disregard chemical variances, strength, electrical properties, and other differences other than uses based loosely on the Quebec Asbestos Mining Association standards.

Crudes, and Groups 1, 2, while not milled, have the same ultimate textile uses as Group 3, and are combined as BM I (spinning). Groups 4 and 5 comprise BM II (shingle and paper). Groups 6 and 7 become BM III (shorts).

Note that the spinning grades (BM I) are found only in four of the major uses. These fibers comprised 3% of the reported tonnages. Shingle and paper grades (BM II) were 47% of the weight of the fibers reported and were in all the major uses but textiles. The remainder, 50% of the reported fibers, were shorts (BM III) and were found in every major use.

The construction field used 24% of the anthophyllite reported, and friction products used 29%. These were the only major uses reported, except for a tiny amount in textiles.

Seventy-two percent of the amosite reported was used for insulation, 18% for construction, and 6% for asphalt felts.

Construction accounted for 88% of the crocidolite and paper for 1%.

Overall consumption in 1972 increased nearly 7% over that of 1971, with no usage trends apparent.

Table 4.—Bureau of Mines chrysotile groupings

BM I (spinning)	BM II (shingle and paper)	BM III (shorts)
	CANADA	
Group 1 (crude) Group 2 (crude) Group 3 AAA, AA, A, AC, CC	Group 4 Group 5 AK, CP, AS, CT, AX, CY, AY	Group 6 Group 7
	ARIZONA	
No. 1 Crude No. 2 Crude AAA	Group No. 3, Group No. 4 Group No. 5	Group No. 6 Group No. 7
	CALIFORNIA	
	Grade 4, Grade 5	Grade 6, Grade 7
	VERMONT	
Grade 3	Grade 4, Grade 5	Grade 6, Grade 7, Grade 8

Table 5.—U.S. asbestos consumption 1972

(Short tons)

End uses	Chrysotile (adjusted)				Anthophyllite (reported)	Amosite (reported)	Crocidolite (reported)
	BM I	BM II	BM III	Total			
Construction	--	214,800	108,600	323,400	218	1,017	13,795
Floor tile	--	4,700	80,000	84,700	--	--	--
Friction products	5,400	24,000	47,600	77,000	262	--	--
Paper	--	2,100	67,200	69,300	--	--	159
Asphalt felts	--	17,000	29,200	46,200	--	351	--
Packing and gaskets	2,000	18,000	10,800	30,800	--	--	24
Insulation	2,600	2,300	10,500	15,400	--	4,131	--
Textiles	7,600	--	100	7,700	3	--	20
Other	1,000	80,800	33,700	115,500	420	206	1,625
Total	18,600	363,700	387,700	770,000	903	5,705	15,623

PRICES

Quoted prices for Quebec asbestos in 1972 were unchanged since July 1, 1971. On January 1, 1973, British Columbia spinning grades were to rise 2% and cement grades 5%. The price of Arizona asbestos was expected to remain unchanged.

Prices for Arizona chrysotile asbestos have remained unchanged since August 1, 1968. Quotations, f.o.b. Globe, were as follows:

Grade	Description	Per short ton
Group 1	Crude	$1,410–$1,650
Group 2	do	700– 950
AAA		800
Group 3	Nonferrous filtering and spinning	425– 700
Group 4	Nonferrous plastic and filtering	400– 500
Group 5	Plastic and filtering	385– 425
Group 6	Refuse or shorts	250
Group 7	do	65– 90

As of January 3, 1973, Vermont Chrysotile asbestos, f.o.b. Morrisville, was priced as follows:

Grade	Description	Per short ton
Grade 4	Shingle fiber	$218.00–$371.00
Grade 5	Paper fiber	157.50– 185.00
Grade 6	Waste, stucco, or plaster fiber	114.00
Grade 7	Shorts and floats	43.50– 95.00

Quotations for Canadian (Quebec) chrysotile, f.o.b. mine, were as follows, as of July 1, 1971:

Grade	Description	Per short ton
Group 1	Crude	Can $1,615
Group 2	do	875
Group 3	Spinning fiber	412–675
Group 4	Shingle fiber	227–383
Group 5	Paper fiber	164–195
Group 6	Waste, stucco, or plaster	120
Group 7	Refuse or shorts	52–100

The increased demand for asbestos used in cement products (groups 5, 7) resulted in greater price increases in these categories. The last price rise for British Columbia emphasizes this point.[2]

Prices for British Columbia, Canada, chrysotile asbestos, f.o.b. Vancouver, will rise January 1, 1973 to the following:

Grade	Description	Per short ton
AAA	Nonferrous spinning fiber	Can $895
AA	do	711
A	do	541
AC	Asbestos cement fiber	388
AK	Shingle fiber	276
CP	do	261
AS	do	240
CT	do	235
AX	do	219
CY	do	155
AY	do	155

Privately negotiated sales are typical of the African asbestos producers. As this rules out market quotations, the following figures are averages, regardless of grade, of the values of South African imports calculated from U.S. Department of Commerce Data:

Type	Per short ton			
	1969	1970	1971	1972 [1]
Amosite	$153	$160	$164	$188
Crocidolite	189	196	212	222
Chrysotile	192	198	120	211

[1] First 8-month data on imports, U.S. Bureau of the Census.

[2] Asbestos. V. 54, No. 7, January 1973, p. 36.

FOREIGN TRADE

The value of exports of asbestos products manufactured in the United States increased 2 percent over the value of those exported in 1971. Five of the nearly 100 countries buying these products accounted for better than 60% of the foreign sales. They were Canada (44%), West Germany (9%), the United Kingdom (4%), Venezuela (2%), and Australia (4%).

In 1972 the United States imported 91% of its asbestos needs. This bettered the 1971 percentage, because of increased demand. Canada provided 97% of the imports, the Republic of South Africa provided 2%, and nine other countries, 1%. Chrysotile, with 98%, dominated the imported types. There was a near 10% increase in the dollar value of imported fibers. The Rhodesian values in table 7 reflect the recent lifting of the 1967 embargo.

Table 6.—U.S. exports and reexports of asbestos and asbestos products

Product	1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
EXPORTS				
Unmanufactured:				
Crude and spinning fibers____short tons__	6,830	$1,376	22,081	$3,786
Nonspinning fibers____do____	21,257	3,453		
Waste and refuse____do____	24,115	2,742	29,711	3,835
Total____do____	52,202	7,571	51,792	7,621
Products:				
Gaskets and packing____do____	2,299	7,698	2,409	7,462
Brake linings____do____	r 5,258	r 7,185	4,496	6,654
Clutch facings, including linings____number__	1,920,176	1,572	2,727,573	1,908
Textiles and yarn____short tons__	6,673	3,397	8,643	4,863
Shingles and clapboard____do____	12,696	2,580	10,366	2,308
Articles of asbestos cement____do____	9,603	3,080	9,649	2,148
Manufactures, n.e.c____	NA	5,897	NA	6,715
Total____	--	r 31,409	--	32,058
REEXPORTS				
Unmanufactured:				
Crude and spinning fibers____short tons__	1,141	229	6,287	1,367
Nonspinning fibers____do____	335	63		
Waste and refuse____do____	--	--	545	63
Total____do____	1,476	292	6,832	1,430
Products:				
Gaskets and packing____do____	1	5	254	11
Brake linings____do____	6	10	--	--
Clutch facings, including linings____number__	422	1	--	--
Textiles and yarn____short tons__	--	--	5	12
Shingles and clapboard____do____	--	--	--	--
Articles of asbestos cement____do____	--	--	100	29
Manufactures, n.e.c____	NA	5	NA	--
Total____	--	21	--	52

r Revised. NA Not available.

Table 7.—U.S. imports for consumption of asbestos (unmanufactured), by class and country

Year and country	Crude (including blue fiber)		Textile fiber		All other		Total	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1971								
Canada____	240	$96	11,620	$5,306	636,782	$69,577	648,642	$74,979
Finland____	--	--	--	--	4,182	342	4,182	342
Italy____	2	4	--	--	--	--	2	4
Mexico____	--	--	18	8	40	3	58	11
Mozambique____	203	43	--	--	157	31	360	74
South Africa, Republic of____	23,188	4,104	1	(1)	1,822	399	25,011	4,503
Swaziland____	160	46	--	--	230	59	390	105
United Kingdom____	--	--	--	--	109	3	109	3
Yugoslavia____	--	--	--	--	2,613	69	2,613	69
Total____	23,793	4,293	11,639	5,314	645,935	70,483	681,367	80,090
1972								
Bolivia____	29	3	--	--	--	--	29	3
Canada____	66	10	11,599	5,316	702,230	78,577	713,895	83,903
Finland____	--	--	--	--	2,243	160	2,243	160
Greece____	--	--	--	--	6	1	6	1
Italy____	--	--	--	--	2	3	2	3
Mozambique____	428	85	--	--	597	118	1,025	203
Rhodesia, Southern____	200	99	--	--	--	--	200	99
South Africa, Republic of____	14,938	3,056	16	7	1,431	220	16,385	3,283
Swaziland____	40	21	--	--	--	--	40	21
Switzerland____	--	--	--	--	4	1	4	1
Yugoslavia____	--	--	843	12	843	43	1,686	55
Total____	15,701	3,274	12,458	5,335	707,356	79,123	735,515	87,732

1 Less than ½ uuit.

Table 8.—U.S. imports for consumption of asbestos from specified countries by grade

(Short tons)

Grade	1971		1972		
	Canada	Republic of South Africa	Canada	Southern Rhodesia	Republic of South Africa
Chrysotile:					
Crudes	188	1,655	66	200	2,439
Spinning fibers	11,620	1	11,599	--	16
All other	636,782	1,822	702,230	--	1,431
Crocidolite (blue)	52	6,953	--	--	5,374
Amosite	--	14,580	--	--	7,125
Total	648,642	25,011	713,895	200	16,385

WORLD REVIEW

Trend analyses such as those shown in figure 1 can reveal a great deal about the changes becoming apparent in the world market. The data were derived by using all the information available for the last 10 years to establish trends by linear regression analysis. The full 10-year figures were available for the United States and Canada, and at least 4 years were available for each of the other countries.

If each of the major consuming countries kept a near-constant share of an expanding market, the result would be a straight line, as shown by Canada. The U.S.S.R. and Japan typify those countries whose consumption rate has increased faster than the world production rate. The United States and the United Kingdom have gone the opposite way.

The United States, with a remarkably stable consumption rate, is taking a smaller share of the expanding market, and it is apparent that it will soon be supplanted by the U.S.S.R. as the world's largest consumer, if this has not already happened.

The same kind of analysis of Canadian data can also be informative, as shown in figure 2. Canada is both the world's largest producer and exporter of asbestos, and a major consumer as well. The marked divergence of the value and production lines shows graphically the inflationary trends. The upward slope of the production and export lines is indicative of the expanding world market. The slight divergence between the production and export lines illustrates that Canada's consumption growth rate exceeds that of production and that an increasing amount of Canadian asbestos is being used domestically.

Australia.—The Woodsreef mine and mill began operation in January 1972 and had such promising prospects that its parent Canadian company (formerly Pacific Asbestos) is now officially Woodsreef Minerals, Ltd. There was an official dedication in April and the mill was approaching full capacity throughout by yearend. This capacity (70,000 tons per year fiber) is felt to be inadequate, and plans for doubling it by 1975 are underway.

Bolivia.—The 3-year United Nations Development Program (UNDP) to assist in establishing an asbestos industry at Cochabamba was terminated in 1972. UNDP called the project a success and thought the operation could function without further assistance.

Canada.—The world's largest producer rebounded from last year's drop in production with a 3% increase in 1972. There were notes of caution from some industry leaders saying that market expansion would proceed at a slower rate and that new markets and applications were essential to a healthy industry. These probably well-founded views, however, were offset by the scurry of activity at producing mines and at those with potentials. This activity hints at a more optimistic viewpoint. Examples of this are—

1. The expansion and modernization of the Canadian Johns-Manville Co., Ltd., mine and mill at Asbestos, Quebec, has not been curtailed. The project neared completion at yearend, and among the new facilities was the world's largest crusher. This 800-ton gyratory crusher can accept the full load of a 200-ton dump truck at one time.

2. The Asbestos Corp's new mine on the Ungava Peninsula went into production and started shipping concentrate to Nordenheim, West Germany. Of real significance is the news that the tailings from

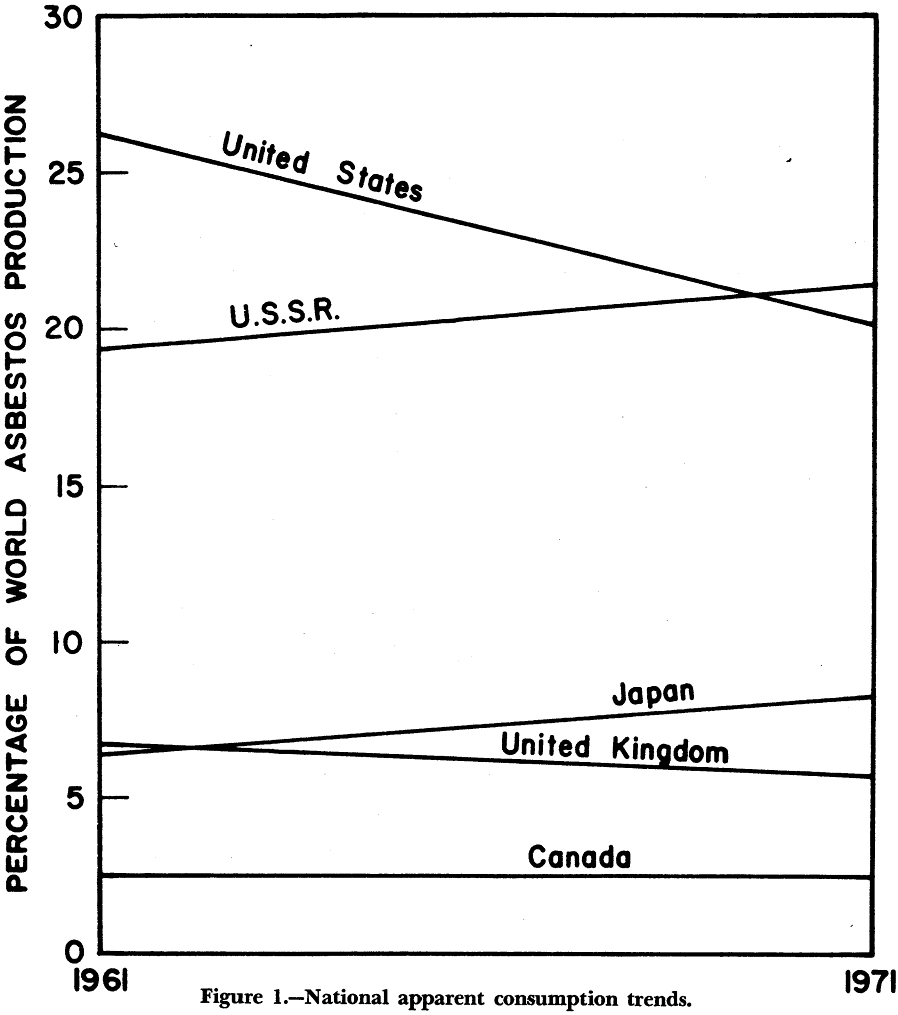

Figure 1.—National apparent consumption trends.

the Nordenheim plant are being used to make a marketable nonfired brick of good quality.

3. Abitibi Asbestos Mining Co., Ltd., has sold an 18% interest in its Amos, Quebec, deposit to Brinco, Ltd., which has an option on a further 33%. The $2 million advanced by Brinco is being used to provide a 35-ton-per-day mill for pilot studies.

4. Pan Ocean Oil Corp. is negotiating with Pathfinder Resources Ltd. over the possible development of an asbestos ore body in Cleveland Township, Quebec.

5. Allied Mining Corp. is planning a merger with United Asbestos Corp. to further the production plans for their Midlothian Township, Ontario, asbestos deposit.

New Zealand.—Kennecott Exploration Ltd., the New Zealand subsidiary of the U.S. company, has reportedly discovered a large asbestos property at Red Hills in West Otago on South Island.

Rhodesia Southern.—Undaunted by strikes early in the year, the Rhodesian and General Asbestos Corp. spent 25 million rand replacing the mill at their King mine. The first asbestos in several years was shipped to the United States.

Sudan.—A United Nations Development

Program survey of an asbestos deposit in the Ingenassa Hills has not yet been made public.

Swaziland.—The Government reached a new agreement with Turner & Newell Ltd. in which a 20% interest in the Havelock asbestos mine would be transferred to the Government immediately without cost and another 20% would be bought from profits over 6 years.

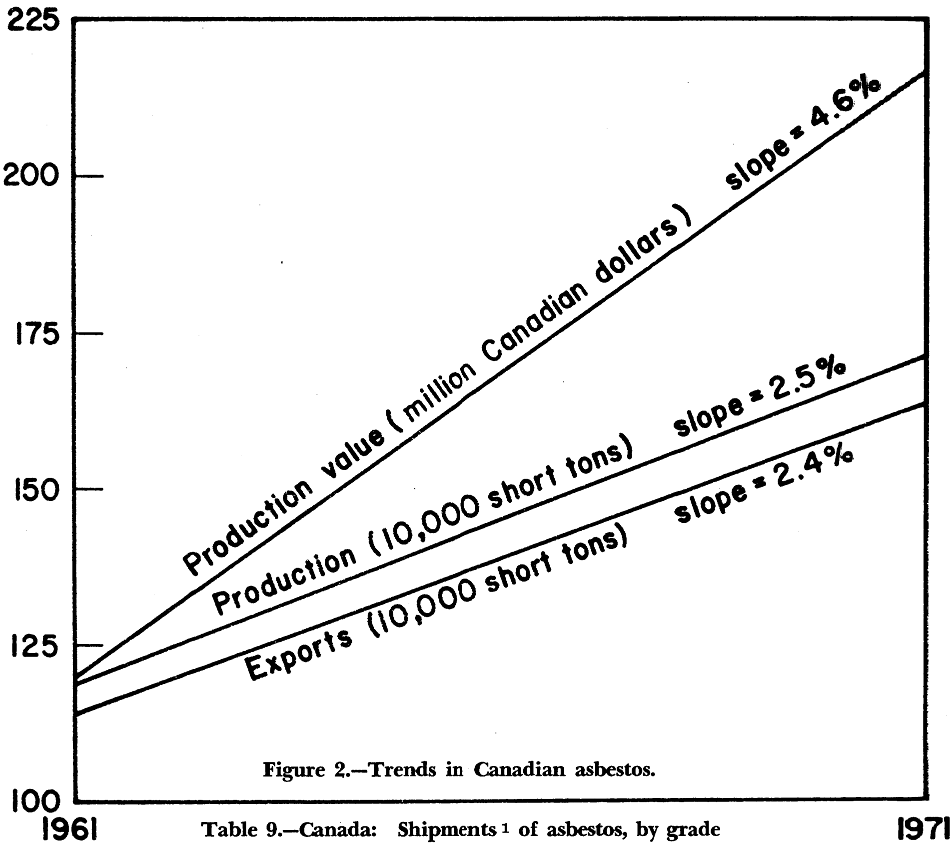

Figure 2.—Trends in Canadian asbestos.

Table 9.—Canada: Shipments[1] of asbestos, by grade
(Short tons)

	1968	1969	1970	1971	1972
Quebec milled group:					
BM I	32,248	29,291	24,648	21,272	21,538
BM II	529,253	530,354	563,647	519,621	508,970
BM III	800,809	783,562	779,229	801,427	847,289
Newfoundland, Ontario, British Columbia, and Yukon	147,389	233,669	294,120	292,342	309,822
Total	1,509,699	1,576,876	1,661,644	1,634,662	1,687,619

[1] Includes tonnage for own use.

Source: Dominion Bureau of Statistics.

Table 10.—Asbestos: World production, by country

(Short tons)

Country [1]	1970	1971	1972 [p]
North America:			
Canada (sales)	1,661,644	1,634,579	1,629,000
United States (sold or used by producers)	125,314	130,882	131,663
Latin America:			
Argentina	39	433	[e] 440
Brazil [e]	18,000	22,000	36,000
Europe:			
Bulgaria	3,307	[e] 3,300	[e] 3,300
Finland [2]	15,019	11,420	7,042
France [e]	550	550	550
Italy	130,663	131,801	145,675
Portugal	223	140	[3] 9
U.S.S.R. [e]	1,175,000	1,270,000	1,345,000
Yugoslavia	13,342	17,011	12,170
Africa:			
Egypt, Arab Republic of	[4] 495	77	[e] 80
Mozambique	251	1,577	589
Rhodesia, Southern [e]	88,000	88,000	88,000
South Africa, Republic of	[r] 320,020	355,228	356,206
Swaziland	36,439	39,114	36,817
Asia:			
China, People's Republic of [e]	190,000	175,000	220,000
Cyprus	28,247	30,531	[5] 30,851
India	10,840	12,122	13,528
Japan	23,451	19,762	15,903
Korea, Republic of (South)	1,513	--	2,155
Philippines	1,337	--	--
Taiwan	3,133	2,565	2,962
Turkey	[r] 3,609	4,291	[e] 4,400
Oceania: Australia	[r] 815	990	[e] 1,000
Total	[r] 3,851,251	3,951,373	4,083,340

[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.

[3] Gross weight.

[4] Includes vermiculite.

[5] Exports only.

Barite

By Frank B. Fulkerson [1]

Domestic barite production totaled over 900,000 tons, an increase of 10% compared with 1971 output. Barite production in Nevada increased 65%. Imports of crude barite advanced 29% compared with those in 1971, which were below average because of a temporary surcharge on dutiable imports. Sales of ground and crushed barite produced from domestic and imported material rose 10% in quantity and 34% in value. Two barium-chemical plants were closed because of depressed market conditions.

Table 1.—Salient barite and barium-chemical statistics

(Thousand short tons and thousand dollars)

	1968	1969	1970	1971	1972
United States:					
Barite (Primary):					
Sold or used by producers	[1] 927	1,077	854	825	906
Value	[1] $13,706	$15,753	$12,800	$13,491	$14,883
Imports for consumption	663	614	706	484	624
Value	$5,666	$5,549	$6,314	$4,468	$5,648
Ground and crushed sold by producers	1,266	1,537	1,388	1,330	1,461
Value	$30,563	$37,297	$34,294	$34,020	$45,590
Barium chemicals sold by producers	136	130	105	83	66
Value	$18,811	$19,101	$16,961	$15,488	$13,869
World: Production	3,769	4,238	4,338	4,231	4,260

[1] Data not comparable to previous years.

Table 2.—Barite (primary) sold or used by producers in the United States, by State

(Thousand short tons and thousand dollars)

State	1971		1972	
	Quantity	Value	Quantity	Value
Alaska	102	1,075	W	W
Arkansas	W	W	W	W
California	W	W	4	34
Georgia	W	W	W	W
Missouri	232	3,606	213	3,637
Nevada	192	1,490	317	2,659
Tennessee	21	342	W	W
Undistributed	278	6,978	372	8,553
Total	825	13,491	906	14,883

W Withheld to avoid disclosing individual company confidential data; included with undistributed.

DOMESTIC PRODUCTION

Barite was produced at 30 mines in seven States. Nevada supplied the largest tonnage, followed by Missouri and Arkansas.

Leading producing companies were Dresser Minerals, Dresser Industries, Inc., with mines in Arkansas, Missouri, and Ne-

[1] Industry economist, Division of Nonmetallic Minerals.

vada; Milchem, Inc., with four mines in Missouri and four in Nevada; Baroid Div., NL Industries, Inc., with two mines in Missouri, one in Arkansas, one in Nevada, and one in Tennessee; and Inlet Oil Corp., with a mine in Alaska.

Ground and crushed barite was produced mainly in Arkansas, Missouri, and Nevada from domestic barite and in Louisiana and Texas from imported material. Processing plants were also located in Alaska, California, Georgia, Illinois, Tennessee, and Utah.

Dresser Minerals was constructing a new beneficiation plant at its Greystone mine, southeast of Battle Mountain, Nev. The new plant was scheduled for completion in 1973.

The Missouri Geological Survey test-drilled four tailings ponds in the Washington County barite district to determine the quantity and size-grade distribution of the barite contained in them. Interest in the ponds was increasing as known barite reserves were progressively being depleted. A district inventory indicated a total of 67 ponds containing an estimated 1.9 million tons of barite. This was equivalent to nearly 10 years' supply at the current production rate.[2]

CONSUMPTION AND USES

About 80% of the ground and crushed barite sold was used as a weighting agent in oil- and gas-well drilling muds; this use increased 139,000 tons. Barite usage for barium-chemical manufacturing decreased 35,000 tons. All other uses increased 18,000 tons.

Producers of barium chemicals from barite included Chemetron Corp., Huntington, W. Va.; Chemical Products Corp., Cartersville, Ga.; Great Western Sugar Co., Johnstown, Colo.; Inorganic Chemicals Div., FMC Corp., Modesto, Calif.; Mallinckrodt Chemical Works, St. Louis, Mo.; PPG In-

[2] Wharton, H. M. Barite Ore Potential of Four Tailings Ponds in the Washington County Barite District, Missouri. Missouri Geol. Survey and Water Res. Rept. of Inv. 53, Rolla, Mo., 1972, 91 pp.

Table 3.—Ground and crushed barite sold, by use [1]

Use [2]	1970		1971		1972	
	Short tons	% of total	Short tons	% of total	Short tons	% of total
Barium chemicals [3]	146,038	10	140,843	10	105,589	7
Glass	49,642	4	(4)	--	(4)	--
Filler or extender:						
Paint	43,919	3	43,439	3	46,342	3
Rubber	25,489	2	(4)	--	(4)	--
Other filler	(4)	--	22,430	2	(4)	--
Well drilling	1,118,973	79	1,044,367	77	1,183,340	80
Other uses	24,565	2	104,318	8	142,183	10
Total	1,408,626	100	1,355,397	100	1,477,454	100

[1] Includes imported barite.
[2] Uses reported by producers of ground and crushed barite, except for barium chemicals.
[3] Quantities reported by consumers.
[4] Included with "Other uses" to avoid disclosing individual company confidential data.

Table 4.—Barium chemicals produced and sold by producers in the United States in 1972 [1]

(Short tons)

Chemical	Plants	Produced	Sold by producers	
			Quantity	Value
Barium carbonate	5	44,611	35,569	$5,247,301
Other barium chemicals [2]	(3)	38,880	30,576	8,621,979
Total [4]	7	83,491	66,145	13,869,280

[1] Only data reported by barium-chemical plants that consume barite are included.
[2] Includes black ash, blanc fixe, chloride, hydroxide, oxide, peroxide, sulfide, and other compounds for which separate data may not be revealed.
[3] Black ash, 1 plant; blanc fixe, 2; chloride, 3; oxide, 1; peroxide, 1; and sulfide, 1.
[4] A plant producing more than 1 product is counted only once in arriving at total.

dustries, Chemical Div., New Martinsville, W. Va.; and Sherwin Williams Chemicals, Coffeyville, Kans.

PPG Industries closed the barium plant at its New Martinsville, W. Va., complex and went out of the barium-chemicals business, owing to depressed markets. Sherwin Williams Chemicals ceased the manufacture of barium carbonate at its Ashtabula, Ohio, plant, but continued to manufacture the product at Coffeyville, Kans.

Use of industrial minerals in oil-well drilling muds was reviewed.[3] Barite and bentonite are by far the most important from the viewpoint of sales value; a variety of other mineral commodities, including lime, soda ash, mica, gypsum, rock salt, and graphite, are also used. The position of barite for mud-weighting purposes seems secure as long as prevailing drilling methods continue.

PRICES

Prices of crude and ground barite generally are negotiated between buyer and seller. Prices of barite published in trade journals serve as a general guide and do not necessarily reflect actual transactions. Quoted prices for imported crude barite decreased in 1972.

The average value per ton excluding container cost of crushed and ground barite f.o.b. plant was $31.20 in 1972, compared with $25.58 in 1971.

Table 5.—Price quotations for crude and ground barite in 1972

Item	Price per ton
Chemical and glass grade, f.o.b. shipping point, carload lots, short ton:	
Hand picked, 95% $BaSO_4$, 1% iron	$22.50–$24.50
Water ground, 99.5% $BaSO_4$, 325 mesh, 50-pound bags	55–78
Drilling-mud grade:	
Ground, 83–93% $BaSO_4$, 3–12% iron, specific gravity 4.20–4.30, f.o.b. shipping point, carload lots, short ton	37–44
Crude, bulk, imported, specific gravity 4.20–4.30, c.i.f. gulf ports, short ton	14–18

Source: Engineering and Mining Journal.

FOREIGN TRADE

Canada and Singapore were the principal countries receiving natural barium sulfate and carbonate exports (mostly ground barite) from the United States. The exports increased from 24,000 tons in 1971 to 52,000 tons in 1972.

Imports of crude barite increased 29% compared with those in 1971. The increase can be attributed in large part to the removal of a 10% ad valorem surcharge that was in effect during the last half of 1971. Declared values of crude barite at foreign ports were as follows for the indicated countries: Ireland, $9.85; Mexico, $10.40; and Peru, $5.47. Imported barite was ground at processing plants in Louisiana and Texas. About 1,300 tons of crushed or ground witherite was imported from the United Kingdom.

Imports of precipitated barium carbonate rose over 600%. The large increase was due mainly to reduced domestic supplies of the chemical because of plant closures. West Germany supplied most of the precipitated barium carbonate. Imports of blanc fixe and barium chloride also increased appreciably.

[3] Jones, G. K. Industrial Minerals in Oil-Well Drilling. Ind. Miner. (London), No. 60, September 1972, pp. 9–31.

Table 6.—U.S. exports of natural barium sulfate and carbonate

Country	1971		1972	
	Short tons	Value (thousands)	Short tons	Value (thousands)
Argentina	20	$2	--	--
Brazil	237	9	165	$6
Canada	8,449	325	35,158	1,383
Colombia	200	7	--	--
Ecuador	--	--	122	23
El Salvador	--	--	80	4
Guatemala	--	--	620	31
Honduras	--	--	100	5
Indonesia	5,385	193	--	--
Jamaica	--	--	50	3
Japan	--	--	38	1
Korea, Republic of	--	--	1,599	58
Malagasy Republic	252	9	--	--
Malaysia	--	--	26	1
Mexico	22	2	69	5
Peru	90	3	--	--
Philippines	1,055	40	24	1
Singapore	7,570	159	13,622	317
South Africa, Republic of	--	--	128	6
Surinam	116	4	--	--
Venezeuela	380	17	578	22
Total	23,776	770	52,379	1,866

Table 7.—U.S. exports of lithopone

Year	Short tons	Value (thousands)
1970	1,541	$523
1971	545	425
1972	1,395	458

Table 8.—U.S. imports for consumption of barite, by country

(Thousand short tons and thousand dollars)

Country	1971		1972	
	Quantity	Value	Quantity	Value
Crude barite:				
Canada	71	601	20	228
France	--	--	(1)	3
Greece	50	491	67	807
Ireland	107	810	154	1,517
Italy	23	319	--	--
Mexico	99	887	140	1,456
Morocco	23	273	41	500
Nicaragua	--	--	16	119
Peru	111	1,087	186	1,018
Total	484	4,468	624	5,648
Ground barite:				
Canada	(1)	3	(1)	3
Colombia	(1)	5	--	--
France	(1)	12	(1)	4
Mexico	(1)	2	--	--
United Kingdom	--	--	(1)	3
Total	(1)	22	(1)	10

[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	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1970	87	$19	2,866	$495	1,558	$166	--	--
1971	81	13	3,522	576	1,446	167	--	--
1972	84	17	6,412	1,691	7,316	938	63	$12

Year	Barium nitrate		Barium carbonate precipitated		Other barium compounds	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1970	786	$118	1,416	$117	525	$258
1971	832	139	1,120	91	799	313
1972	685	126	8,316	841	716	334

Table 10.—U.S. imports for consumption of crude, unground, and crushed or ground witherite

Year	Crude, unground		Crushed or ground	
	Short tons	Value (thousands)	Short tons	Value (thousands)
1970	--	--	182	$35
1971	417	$22	94	20
1972	--	--	1,311	169

WORLD REVIEW

Canada.—Barite output in Canada decreased owing to operating difficulties at the Walton mine, Dresser Minerals Division, Dresser Industries, Inc., in Nova Scotia. The mine flooded late in 1970, and the only production after that time has come from stockpiles and quarried material.

International Mogul Mines, Ltd., continued to evaluate the Lake Ainslie barite-fluorite deposits on Cape Breton Island in Nova Scotia. A preliminary economic appraisal indicated production of drilling-mud-grade barite and sub-acid-grade fluorspar from the deposits would be unprofitable.[4]

Indonesia.—IMCO Services, Division of Halliburton Co., was building a barite-grinding plant at Makassar. The plant was to be operational in 1973.[5]

Ireland.—Milchem, Inc., was constructing a barite flotation plant for treatment of the Irish Base Metals, Ltd., tailings pond in County Galway. Plant capacity was estimated at 60,000 tons of concentrate per year.[6]

Pakistan.—Following the discovery of large barite reserves in three outlying districts, the government of Baluchistan Province planned to build a barite-grinding plant at Khuzdar. The bulk of the output was to be exported.[7]

U.S.S.R.—A new 3,000-foot-deep central hoisting shaft was completed at the Atchisai lead-barite mining complex in southern Kazakhstan. The new deep shaft gave access to the troughs of the steeply folded synclines. The ore in the anticlines and flanks of the folds was being mined through the Mirgalimsay and Mirginskialie shafts.[8]

United Kingdom.—The United Kingdom imports about three-fourths of its barite requirements.[9] Morocco is the largest source. Imports, which currently total about 75,000 tons per year, are increasing

[4] Zurowski, M. Barite-Fluorite Deposits of Lake Ainslie—An Appraisal from an Economic Viewpoint. Can. Min. and Met. Bull., v. 65, No. 728, December 1972, pp. 60–63.
[5] Mining Engineering. V. 25, No. 1, January 1973, p. 27.
[6] The Mines Magazine Golden, Colo. V. 63, No. 1, January 1973, p. 20.
[7] Industrial Minerals (London). No. 63, December 1972, p. 50.
[8] World Mining. Soviet Lead-Barite Mine Expansion Plan Complete. V. 8, No. 12, November 1972, p. 45.
[9] Collins, R. S. Barium Minerals. Miner. Res. Div., Inst. Geol. Sci. (London), 1972, 44 pp.

rapidly because of exploration for oil and gas in the North Sea. Domestic barite production comes from mines in Derbyshire and Yorkshire. Production of witherite (natural barium carbonate) ended when the Settlingstones mine in Northumberland closed in 1969.

Clay Cross Co., Ltd., planned to produce 8,000 tons of byproduct barite annually at its new fluorspar heavy-media separation plant at Milltown in Derbyshire.[10] The barite will be used mainly for drilling muds.

[10] Industrial Minerals (London). Clay Cross Fluorspar Expansion. No. 64, January 1973, p. 29.

Table 11.—Barite: World production by country

(Short tons)

Country [1]	1970	1971	1972 p
North America:			
Canada	147,251	120,765	73,000
Mexico	351,738	308,362	288,147
United States [2]	854,132	825,000	906,000
South America:			
Argentina	r 27,392	22,641	e 22,600
Brazil e	28,200	47,100	51,000
Chile	1,700	1,413	2,864
Colombia	7,519	6,382	e 7,000
Peru	r 260,499	e 260,000	e 260,000
Europe:			
Austria	347	870	223
Czechoslovakia e	8,300	8,300	8,300
France	r 104,477	121,254	e 121,000
Germany, East e	33,000	33,000	33,000
Germany, West	454,798	450,693	406,434
Greece [3]	r 59,625	93,635	e 94,000
Ireland	243,600	216,160	e 220,000
Italy	239,555	222,144	200,365
Poland e	55,000	61,000	55,000
Portugal	r 1,190	1,268	e 1,300
Romania e	128,400	128,000	128,000
Spain	93,219	91,789	e 93,000
U.S.S.R. e	314,000	331,000	342,000
United Kingdom e	r 29,000	r 29,000	29,000
Yugoslavia	87,886	71,308	e 66,000
Africa:			
Algeria [4]	56,927	40,234	57,902
Egypt, Arab Republic of	237	321	e 330
Kenya	493	819	692
Morocco	93,421	93,117	102,779
South Africa, Republic of	r 3,199	3,265	2,775
Swaziland	373	159	(5)
Tunisia	2,134	1,965	1,310
Asia:			
Burma	14,840	25,312	28,627
China, People's Republic of e	165,000	154,000	171,000
India	r 82,500	64,700	50,831
Iran [6]	r 83,000	66,000	e 66,000
Japan	72,674	63,096	66,659
Korea, North e	132,000	132,000	132,000
Pakistan	2,060	3,265	2,648
Thailand	18,177	70,040	107,024
Turkey	r 32,566	31,468	e 34,000
Oceania: Australia	47,193	30,156	e 27,000
Total	r 4,337,622	4,231,001	4,259,810

e Estimate. p Preliminary. r Revised.

[1] In addition to the countries listed, Bulgaria, Philippines, 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] Barite concentrates; total crude output reported as follows in short tons: 1970—114,270; 1971—153,110; 1972—153,000 (estimate).

[4] Ground barite; total crude output reported as follows in short tons: 1970—80,906; 1971—30,534; 1972—66,000 (estimate).

[5] Less than ½ unit.

[6] Year beginning March 21 of that stated.

TECHNOLOGY

A Canadian patent was issued on the froth flotation of barite or celestite ores. The aqueous pulp of ore was treated with the required reagents, including as an improved collector for the values, a fatty acid taurate amide of prescribed formula or a mixture of fatty acid taurate amides. The values were selectively floated in the froth.[11]

[11] Wyman, E. A. (assigned to Minister of Energy, Mines, and Resources). Froth Flotation of Barite or Celestite Ore. Can. Pat. 914,809, Nov. 14, 1972.

Bauxite

By Horace F. Kurtz [1]

World production of bauxite and alumina increased in 1972, but the increases were the smallest in recent years. The rate of growth in bauxite production was slowed because it had increased in 1970 and 1971 much faster than primary aluminum production, the principal end use for bauxite. Alumina production, the intermediate step between bauxite and aluminum production, has not increased as fast as bauxite output; however, in 1972 world alumina capacity was increased an estimated 13%. New alumina plants put into operation included two each in Australia and Japan and one each in Jamaica, Italy, and Hungary.

Bauxite and alumina production in the United States declined, but imports of alumina increased significantly.

Legislation and Government Programs.—About 586,000 long tons of Surinam-type metallurgical-grade bauxite sold in 1971 was removed from Government stockpiles during 1972. Jamaica-type bauxite was authorized for sale or exchange for other commodities needed to meet stockpile objectives, but none was sold.

[1] Industry economist, Division of Nonferrous Metals.

Table 1.—Salient bauxite statistics

(Thousand long tons and thousand dollars)

	1968	1969	1970	1971	1972
United States:					
Production, crude ore (dry equivalent)	1,655	1,843	2,082	1,988	1,812
Value	23,752	25,725	30,070	28,543	23,238
Exports (as shipped)	7	5	3	34	29
Imports for consumption [1]	10,976	12,160	12,620	12,326	11,428
Consumption (dry equivalent)	14,097	15,580	15,673	15,619	15,375
World: Production	45,256	51,008	56,873	62,506	64,795

[1] Import figures for Jamaica, Haiti, and the Dominican Republic were adjusted by the Bureau of Mines to dry equivalent. Other bauxite imports, which are virtually all dried, are on an as-shipped basis. Excludes calcined bauxite and bauxite imported into the Virgin Islands.

DOMESTIC PRODUCTION

The production of bauxite in the United States declined 9% to 1.8 million long tons (dry equivalent) in 1972. Arkansas produced 90% of the total. Most of the remainder was mined in Alabama, and a small quantity was produced in Georgia. Except for the Mars Hill underground mine of Reynolds Mining Corp. in Saline County, Ark., all of the bauxite mines were open pit operations.

In Arkansas, Reynolds, Aluminum Co. of America (Alcoa), and American Cyanamid Co. mined in Saline County, and A. P. Green Refractories Co. produced in Pulaski County. Bauxite processing plants were operated in Arkansas by American Cyanamid, A. P. Green, Norton Co., Porocel Corp., and Stauffer Chemical Co.

Bauxite was mined in Barbour County, Ala., by A. P. Green, Eufaula Bauxite Mining Co., and Wilson-Snead Mining Co. In Henry County the producers were Abbeville Lime Co., Harbison-Walker Refractories Co., and Wilson-Snead. Drying or calcining facilities were operated by Eufaula Bauxite, Wilson-Snead, A. P. Green, and Harbison-Walker.

In Georgia, American Cyanamid operated two mines and a drying plant in Sumter County.

Table 2.—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:						
1968	110	83	694	74	69	898
1969	117	88	1,020	72	79	1,324
1970 [2]	270	213	3,778	149	161	3,299
1971	261	207	3,564	143	171	3,566
1972	227	178	2,228	187	218	4,605
Arkansas:						
1968	1,961	1,582	23,058	1,962	1,680	25,349
1969	2,116	1,755	24,706	2,044	1,765	26,304
1970	2,251	1,869	26,293	2,194	1,917	29,049
1971	2,157	1,781	24,979	2,161	1,892	28,296
1972	1,973	1,634	21,010	2,128	1,844	25,426
Total United States: [3]						
1968	2,071	1,665	23,752	2,036	1,749	26,247
1969	2,233	1,843	25,725	2,116	1,844	27,628
1970 [2]	2,522	2,082	30,070	2,343	2,078	32,348
1971	2,419	1,988	28,543	2,305	2,063	31,862
1972	2,200	1,812	23,238	2,314	2,061	30,032

[1] Computed from selling prices and values assigned by producers and from Bureau of Mines estimates.
[2] Includes data for Oregon and Washington.
[3] Data may not add to totals shown because of independent rounding.

Table 3.—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
1968	210	108	152
1969	288	162	218
1970	428	259	343
1971	444	250	357
1972	399	210	319

[1] Dried, calcined, and activated bauxite.

Table 4.—Percent of domestic bauxite shipments, by silica content

SiO_2 (%)	1968	1969	1970	1971	1972
Less than 8	15	15	19	4	6
From 8 to 15	53	55	54	65	64
More than 15	32	30	27	31	30

Table 5.—Production and shipments of alumina in the United States

(Thousand short tons)

Year	Calcined alumina	Other alumina [1]	Total	
			As produced or shipped [2]	Calcined equivalent
Production: [3]				
1970	6,670	478	7,148	7,001
1971	6,545	668	7,213	7,002
1972	6,235	741	6,976	6,739
Shipments:				
1970	6,631	476	7,106	6,961
1971	6,525	659	7,184	6,975
1972	6,222	745	6,968	6,730

[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 6.—Capacities of domestic alumina plants, December 31, 1972 [1]

(Thousand short tons per year)

Company and plant	Capacity
Aluminum Co. of America:	
Bauxite, Ark	375
Mobile, Ala	1,025
Point Comfort, Tex	1,350
Total	2,750
Martin Marietta Aluminum, Inc.: St. Croix, V.I.	360
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	7,760

[1] Capacity may vary depending upon the bauxite used.

The production of alumina and aluminum oxide products at the eight alumina plants in the continental United States and the plant in the Virgin Islands totaled 6.98 million short tons in 1972, a decline of 3%. The total production included 6.23 million tons of calcined alumina, 671,000 tons of commercial alumina trihydrate, and 70,000 tons of tabular, activated, and other alumina. The production of commercial alumina trihydrate increased 12% and reached a level more than double the output in 1968.

Shipments of alumina were 6.97 million tons, valued at $497 million. Approximately 6.02 million tons were shipped to primary aluminum plants. The chemical industry, including the producers of aluminum fluoride fluxes for aluminum plants, received the second largest tonnage, and most of the rest of the alumina was shipped to producers of abrasives, ceramics, and refractories.

CONSUMPTION AND USES

The consumption of bauxite in the United States (including the Virgin Islands) in 1972 decreased 2% to 15.4 million long tons (dry basis). Most of the decline resulted from lower production of calcined alumina for the aluminum industry. About 87% of the bauxite consumed was imported ore.

The production of alumina and related products accounted for 93% of the total bauxite consumption. An average of 2.13 long dry tons of bauxite was used to produce 1 short ton (calcined basis) of alumina. The two alumina plants in Arkansas were based mainly on the use of domestic bauxite, and the other seven alumina plants used only imported ore.

Bauxite consumption by the refractories industry reached a record high level of over 400,000 long tons (dry basis). Nearly all of this bauxite was used in the calcined form, and 82% was imported, mainly from

Table 7.—Bauxite consumed in the United States, by industry

(Thousand long tons, dry equivalent)

Year and industry	Domestic	Foreign	Total [1]
1971:			
Alumina	1,665	12,968	14,633
Abrasive [2]	--	207	207
Chemical	[3] 175	[3] 223	319
Refractory	71	309	380
Other	W	W	79
Total [1] [2]	1,911	13,707	15,619
1972:			
Alumina	1,733	12,626	14,359
Abrasive [2]	--	253	253
Chemical	[3] 142	[3] 218	284
Refractory	75	329	403
Other	W	W	76
Total [1] [2]	1,950	13,425	15,375

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.

Guyana. The use of bauxite for the manufacture of refractories has increased every year but one since 1958 when consumption was 60,000 tons.

The use of bauxite to make artificial abrasives also increased in 1972 to about the average level of the past decade. All of the bauxite used by the abrasives industry was calcined. Most of the ore came from Surinam, and the remainder came from Australia and Guyana. Data on consumption by the abrasives industry included bauxite fused and crushed in Canada since much of this material is made into abrasive wheels and coated products in the United States.

Chemical producers decreased their consumption of bauxite by 11% during the year. Other consumers of bauxite, in descending order of magnitude, included the cement, oil and gas, and steel and ferroalloys industries, and municipal waterworks.

Table 8.—Crude and processed bauxite consumed in the United States in 1972

(Thousand long tons, dry equivalent)

Type	Domestic origin	Foreign origin	Total [1]
Crude	1,748	6,857	8,604
Dried	18	5,981	5,998
Activated	7	--	7
Calcined	178	588	765
Total [1]	1,950	13,425	15,375

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

Calcined alumina consumed by the 30 primary aluminum plants in the United States totaled 7.94 million short tons, an increase of 5.6%. Alumina consumption data for other uses were not available. A significant quantity was used to make aluminum fluoride and synthetic cryolite, which is also used in the production of primary aluminum.

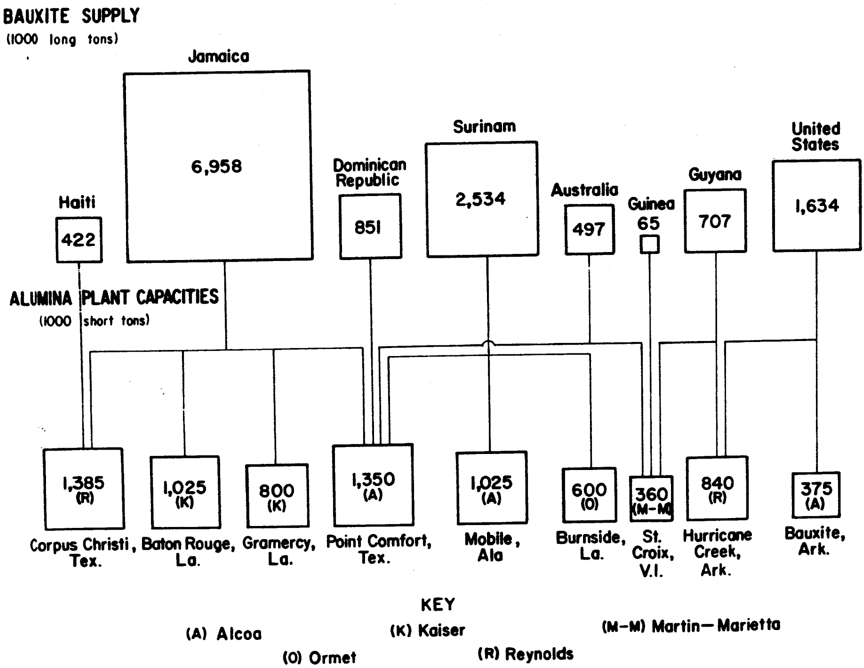

Figure 1.—Principal sources of bauxite for alumina plants in the United States and the Virgin Islands in 1972.

Table 9.—Production and shipments of selected aluminum salts in the United States in 1971

(Thousand short tons and thousand dollars)

Item	Number of producing plants	Production	Total shipments including interplant transfers	
			Quantity	Value
Aluminum sulfate:				
Commercial (17% Al_2O_3)	66	1,195	1,133	47,071
Municipal (17% Al_2O_3)	3	6	XX	XX
Iron-free (17% Al_2O_3)	21	68	45	2,568
Aluminum chloride:				
Liquid (32°Bé) } Crystal (32°Bé) }	5	20	8	828
Anhydrous (100% $AlCl_3$)	5	29	30	8,743
Aluminum fluoride, technical	6	158	156	36,742
Aluminum hydroxide, trihydrate (100% $Al_2O_3.3H_2O$)	7	476	439	39,591
Other inorganic aluminum compounds [1]	XX	XX	XX	24,207
Total	XX	XX	XX	159,750

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

Consumers inventories of bauxite increased during the year, but stocks at mines and processing plants declined sufficiently to account for a net decrease of 3% in total industry inventories. Government stockpiles were reduced 4%. About 586,000 long tons of Surinam-type bauxite was shipped from Government defense inventories and an additional 110,000 tons of bauxite was shipped from a Government stockpile accumulated during World War II.

Total inventories of alumina and related products at plants producing alumina and primary aluminum were 1,079,000 short tons on December 31, 1972, virtually unchanged from 1971 yearend stocks.

Table 10.—Stocks of bauxite in the United States [1]

(Thousand long tons, dry equivalent)

Sector	Dec. 31, 1971 [r]	Dec. 31, 1972
Producers and processors	997	786
Consumers	2,667	2,769
Government [2]	17,149	16,453
Total	20,813	20,008

[r] Revised.
[1] Domestic and foreign bauxite; crude, dried, calcined, activated; all grades.
[2] Includes bauxite stockpiled during World War II (891,000 tons Dec. 31, 1971, 781,000 tons Dec. 31, 1972) plus bauxite in defense material inventories (national stockpile, supplemental stockpile, Defense Production Act).

PRICES

Market prices for domestic crude (undried) and dried bauxite were not published. Bureau of Mines estimates of the value of bauxite production were based on data supplied by producers. Data for most of the crude bauxite came from companies which produce bauxite for their own use rather than for sale. The Bureau estimated the average value of crude domestic bauxite shipments in 1972, f.o.b. mine or plant, at $10.60 per long ton. The average values of shipments of domestic dried and calcined bauxite were estimated at $14.39 and $3.38 per ton, respectively. Bauxite values among producers varied widely because of differences in grade. The average value of imported dried or partly dried bauxite consumed at domestic alumina plants was estimated at $14.79 per long dry ton, compared with $14.39 (revised) for 1971. During 1972, Engineering and Mining Journal published the following prices on refractory-grade bauxite, carlots, Atlantic ports, per long ton:

	January–September	October–December
87.75% minimum Al_2O_3	$47.50	$47.50
88% Al_2O_3 (super calcined)	51.00	60.50

Table 11.—Market quotations on alumina and aluminum compounds

(In bags, carlots, freight equalized)

Compounds	Jan. 3, 1972	Jan. 1, 1973
Alumina, calcined per pound	$0.06	$0.06
Alumina, hydrated, heavy do	0.0445-.0455	0.0445-.0455
Alumina, activated, granular, works do	.1365	.1365
Aluminum sulfate, commercial, ground (17% Al_2O_3) per ton	62.25	67.25
Aluminum sulfate, iron-free, dry (17% Al_2O_3) do	87.05	92.05

Source: Chemical Marketing Reporter.

Table 12.—Average value of U.S. exports and imports of bauxite [1]

(Per long ton)

Type and country	Average value, port of shipment		
	1970	1971	1972
Exports: Bauxite and bauxite concentrate	$74.74	$45.02	$44.59
Imports:			
Crude and dried:			
Australia	(2)	10.68	11.24
Brazil	--	8.57	--
Costa Rica	--	--	35.56
Dominican Republic [3]	16.88	16.58	17.92
Greece	10.14	8.41	14.33
Guinea	4.80	4.93	5.37
Guyana	9.84	11.20	10.09
Haiti [3]	10.02	9.86	10.79
Jamaica [3]	12.99	12.76	13.48
Netherlands	9.00	--	--
Sierra Leone	--	--	11.46
Surinam	10.59	11.12	11.96
Venezuela	9.30	--	--
Average	12.39	12.46	13.21
Calcined:			
Australia	--	--	37.16
Canada	19.62	34.12	44.53
Guinea	--	90.28	--
Guyana	34.77	39.85	50.49
Mexico	--	64.05	--
Surinam	32.63	34.87	47.20
Trinidad and Tobago	11.97	39.21	54.23
Venezuela	35.20	--	--
Average	34.59	39.33	50.04

[1] Excludes bauxite into the Virgin Islands from foreign countries 1970—Australia $4.91, Guinea $4.51; 1971—Australia $5.54, Papua (New Guinea) $4.31, Guinea $4.94; 1972—Australia $4.74, Guinea $4.82, Guyana $7.01.
[2] Less than ½ unit.
[3] Dry equivalent tons adjusted by Bureau of Mines used in computation.

Note: Bauxite is not subject to an ad valorem rate of duty, and the average values may be arbitrary for accountancy between allied firms, etc. Consequently, the data do not necessarily reflect market values in the country of origin.

The average value of calcined alumina shipments, as determined from producers reports, was $65.60 per short ton. Shipments of alumina trihydrate averaged $76.67 per ton. The average value of imported alumina (including small quantities of aluminum hydroxide) was $60.85 per ton at port of shipment. Exports of alumina from the United States and the Virgin Islands averaged $71.67 per ton.

FOREIGN TRADE

Exports from the United States classified as "bauxite and concentrates of aluminum excluding alumina" totaled 29,000 long tons and were valued at $1.3 million in 1972. Canada received 13,000 tons, with an average value of $60.87 per ton, and Japan received 12,000 tons, with an average value of $14.10 per ton.

Exports of alumina, including 41,000 tons of aluminum hydroxide, declined 19% to 879,000 short tons. Most of the decline resulted from reduced shipments to the U.S.S.R.; however, Canada and the U.S.S.R. remained the largest recipients. Additional shipments of 275,000 tons of alumina were made from the Virgin Islands to foreign countries.

Aluminum sulfate exports, which were shipped mainly to Canada and Venezuela, totaled 5,000 tons and were valued at $181,000. Exports of artificial corundum or fused aluminum oxide totaled 18,000 tons and were valued at $7.25 million. Canada received 7,000 tons. Exports classified as "other aluminum compounds" totaled 45,000 tons and were valued at $10.5 million. Much of this tonnage was believed to be aluminum fluoride and synthetic cryolite shipped to primary aluminum plants in other countries.

No duties were imposed on imports of bauxite, alumina, or aluminum hydroxide in 1972. All duties on these commodities were suspended effective July 15, 1971.

Imports of crude, partially dried, and dried bauxite decreased for the second consecutive year to 11.4 million long tons, as receipts from all of the four largest supplying countries declined. The decrease of 9% from the record high year of 1970

Table 13.—U.S. exports of alumina,[1] by country

(Thousand short tons and thousand dollars)

Country	1970		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value
Canada	400	27,738	273	21,350	282	21,119
Germany, West	12	2,546	23	2,647	2	1,383
Ghana	153	10,240	109	7,207	106	5,652
Hungary	14	1,032	60	3,594	44	2,594
Mexico	89	6,379	97	6,528	109	7,572
Poland	--	--	19	1,381	43	3,182
Sweden	18	1,206	10	717	19	1,351
U.S.S.R.	325	18,935	434	24,751	237	12,835
Venezuela	36	2,690	17	1,417	20	1,577
Other countries	53	9,155	38	8,035	17	8,437
Total	1,100	79,921	1,080	77,627	879	65,702

[1] Includes exports of aluminum hydroxide: 1970—41,000 short tons; 1971—34,000 short tons; 1972—41,000 short tons.

Note: Excludes alumina exported from the Virgin Islands to foreign countries: 1970—Norway 165,000 tons; 1971—Norway 116,000 tons, U.S.S.R. 65,000 tons; 1972—Cyprus 26,000 tons, Norway 191,000, Poland 58,000 tons.

Table 14.—U.S. imports for consumption of bauxite (crude and dried), by country [1]

(Thousand long tons and thousand dollars)

Country	1970		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value
Australia	--	--	139	1,485	277	3,116
Dominican Republic	910	15,363	912	15,119	851	15,258
Greece	58	588	34	286	3	43
Guinea	15	72	15	74	8	43
Guyana	317	3,118	271	3,034	360	3,635
Haiti	617	6,183	502	4,951	422	4,556
Jamaica	7,503	97,500	7,583	96,767	6,958	93,860
Sierra Leone	--	--	--	--	15	172
Surinam	2,923	30,969	2,870	31,923	2,534	30,327
Venezuela	276	2,560	--	--	--	--
Other countries	1	9	--	--	(2)	2
Total	12,620	156,362	12,326	153,639	11,428	151,012

[1] Official Bureau of the Census data for Jamaican, Haitian, and Dominican Republic bauxite have been converted to dry equivalent by deducting free moisture for 1970; Jamaican 16%, Haitian 12.5%, and Dominican Republic 17.7%; 1971-72 Jamaican is 15.4%, Haitian 13%, and Dominican Republic 16.8%. Other imports which are virtually all dried, are on as-shipped basis.

[2] Less than ½ unit.

Note: Excludes bauxite imported into the Virgin Islands from foreign countries: 1970—Australia 235,000 tons, Guinea 506,000 tons; 1971—Australia 393,000 tons, Papua (New Guinea) 30,000 tons, Guinea 588,000 tons; 1972—Australia 220,000 tons, Guinea 57,000 tons, Guyana 347,000 tons.

Table 15.—U.S. imports for consumption of bauxite (calcined) by country

(Thousand long tons and thousand dollars)

Country	1970		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value
Guyana	237	8,249	247	9,857	185	9,342
Surinam	16	513	30	1,040	35	1,652
Trinidad and Tobago	1	5	15	579	21	1,139
Other countries	2	85	(1)	11	6	229
Total	256	8,852	292	11,487	247	12,362

[1] Less than ½ unit.

Table 16.—U.S. imports for consumption of alumina,[1] by country

(Thousand short tons and thousand dollars)

Country	1970		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value
Australia	1,185	66,278	1,240	66,634	1,168	67,674
Canada	20	2,320	17	1,883	20	2,136
France	38	2,420	84	5,135	23	1,936
Germany, West	20	1,894	3	755	1	433
Greece	27	1,230	63	3,951	107	6,138
Guyana	39	2,379	13	929	58	3,534
Jamaica	868	55,866	458	30,681	748	48,836
Japan	36	4,076	68	4,968	138	8,599
Surinam	346	20,122	463	26,851	571	32,916
Other countries	(2)	102	1	117	16	1,211
Total	2,579	156,687	2,410	141,904	2,850	173,413

[1] Includes small quantities of aluminum hydroxide previously not included.
[2] Less than ½ unit.

Note: Shipments from the Virgin Islands to the United States: 1970—119,000 short tons ($9,550,000); 1971—120,000 short tons ($9,316,000); 1972—67,051 short tons ($4,827,674).

was attributed to a reduction of domestic stocks of bauxite, increased imports of alumina, and a slowing down in the growth of primary aluminum production during this period. Bauxite imports into the Virgin Islands also declined from a record level reached in 1971.

Calcined bauxite imports into the United States fell 15% to 247,000 tons, reflecting decreased receipts of refractory-grade bauxite from Guyana. Except for 6,000 tons received from Australia, all of the calcined bauxite originated in Guyana or Surinam.

Imports of alumina, including small quantities of aluminum hydroxide, increased 18% to 2.85 million short tons. Receipts from Jamaica alone increased nearly 300,000 tons as new alumina capacity owned by United States aluminum producers came onstream. Australia provided 41% of the total imports, Jamaica 26%, and Surinam 20%.

WORLD REVIEW

World production of bauxite increased 4% in 1972. Australia, the largest bauxite-producing country, showed the greatest increase, and Australia and Jamaica together produced over 40% of the world's supply. Bauxite production in Guyana and Greece declined appreciably, but future output in these countries was expected to increase.

World alumina production registered a small increase, however, Jamaica's output gained 18%. The United States produced 27% of the world's alumina, declining steadily from 35% in 1969.

Australia.—Alcoa of Australia (W.A.) N.L. continued production of alumina at its Kwinana plant 20 miles south of Perth, Western Australia, and in May began production at a new plant at Pinjarra, about 50 miles south of Perth. The initial annual capacity of the first two units at the Pinjarra plant was 463,000 short tons and reportedly cost over $50 million. The plant

Table 17.—Bauxite: World production by country

(Thousand long tons)

Country [1]	1970	1971	1972 [p]
North America:			
Dominican Republic [2]	1,050	1,291	[3] 1,208
Haiti [4]	[r] 622	633	677
Jamaica [5]	11,820	12,244	12,345
United States [2]	2,082	1,988	1,812
South America:			
Brazil	492	530	596
Guyana [2]	4,347	4,167	3,668
Surinam	5,927	6,612	[e] 6,800
Europe:			
France	[r] 2,945	3,134	3,203
Germany, West	3	3	[e] 3
Greece	[r] 2,256	2,816	2,398
Hungary	1,990	2,057	2,321
Italy	221	191	95
Romania	299	[e] 300	[e] 300
Spain [6]	[r] 5	5	[e] 5
U.S.S.R. [e 7]	4,200	4,400	4,600
Yugoslavia	2,066	1,928	2,162
Africa:			
Ghana	[r] 337	324	335
Guinea	2,451	2,588	[e] 2,600
Mozambique	7	7	5
Sierra Leone	433	581	683
Asia:			
China, People's Republic of [e 8]	490	540	570
India	1,338	1,493	1,633
Indonesia	1,210	1,218	1,256
Malaysia (West Malaysia)	1,121	962	1,059
Pakistan	1	(9)	1
Turkey	50	151	255
Oceania: Australia	[r] 9,110	12,343	14,205
Total	[r] 56,873	62,506	64,795

[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, but no information on bauxite mining activities, if any, are available since 1965.
[2] Dry bauxite equivalent of crude ore.
[3] Exports.
[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] Previous year table indicated metal content.
[7] Excludes materials other than bauxite used for the production of alumina, estimated as follows in thousand long tons: nepheline concentrates (25 to 30% aluminum)— 1970, 390; 1971, 490; 1972, 590; alunite ore (16 to 18% aluminum)—1970, 195; 1971, 295; 1972, 295.
[8] Diasporic bauxite for production of aluminum only; excludes 98,000 to 195,000 tons of production for refractory applications.
[9] Less than ½ unit.

was to be increased to 880,000 tons by the end of 1974 and eventually to a capacity larger than that of Kwinana. Both alumina plants use bauxite from the Darling Range, and reserves have been estimated to be on the order of 500 million tons. The Pinjarra plant is supplied by a 4-mile conveyor belt from the Del Park deposit. Alcoa's deposits and the mining and treatment of bauxite from Del Park were described.[2]

American Metal Climax, Inc. (AMAX), postponed the development of its proposed bauxite-alumina complex in the Kimberley area, Western Australia, and announced the signing of a contract to purchase an additional 440,000 tons per year of alumina from Alcoa's plant at Pinjarra beginning in 1975. The Government of Western Australia extended the effective dates on the Kimberly bauxite claims of Amax Bauxite Co. to 1984 so that the development of this project could be reconsidered under different marketing and financing conditions. The postponement was attributed to difficulty in financing the project through an international consortium on a scale large enough to be economical.

Comalco Ltd. completed a 2½-year expansion program to increase its capacity to produce and ship bauxite from Weipa, Queensland, to 10.5 million tons per year. Estimates of bauxite reserves in the Weipa field range from 2.2 to 2.5 billion tons. Comalco reported that it had opened a new mining area at Andoom, about 12

[2] Baker, R. Del Park Bauxite Project. Min. Mag. (London), v. 127, No. 4, October 1972, pp. 351–355.

Table 18.—Alumina: World production by country

(Thousand short tons)

Country [1]	1970	1971	1972 p
North America:			
Canada	1,218	1,257	e 1,250
Jamaica (exports)	r 1,892	1,997	2,355
United States	7,148	7,213	6,976
South America:			
Brazil	131	184	212
Guyana	r 349	342	e 273
Surinam	1,118	1,407	e 1,400
Europe:			
Czechoslovakia e	80	80	80
France	1,246	1,339	1,226
Germany, East	60	52	e 55
Germany, West	835	911	1,010
Greece	344	511	e 513
Hungary	486	515	573
Italy	346	284	227
Norway e	3	--	--
Romania e	231	231	231
United Kingdom	118	109	e 110
U.S.S.R. e	2,000	2,200	2,400
Yugoslavia	138	136	e 176
Africa: Guinea	672	733	e 772
Asia:			
China, People's Republic of e	280	300	310
India e	360	400	400
Japan	1,416	1,767	1,813
Taiwan	46	47	58
Oceania: Australia	r 2,372	2,944	3,144
Total	r 22,889	24,959	25,564

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: 1970—30,354; 1971—30,011; 1972—28,943.

miles south of Weipa. Bauxite production was increased to 7.6 million long dry tons in 1972. Shipments declined to 6.9 million tons of beneficiated bauxite, of which 3.0 million tons were shipped for processing to alumina in Australia, 1.8 million tons to Japan, and 2.1 million tons to Europe and other countries. Shipments of calcined bauxite for use in making aluminous abrasives increased.

Comalco's Bell Bay alumina plant continued to operate at its capacity of 65,000 short tons of alumina. Construction of the third phase of expansion at the Gladstone plant of Queensland Alumina Ltd. was delayed by work stoppages. At yearend the expansion was expected to be completed by the third quarter 1973, at which time the alumina plant, the largest in the world, should have a rated annual capacity of 2.24 million tons. Production at Gladstone in 1972 increased 3% to 1.5 million short tons.

In July, Nabalco Pty., Ltd., brought into production its new alumina plant at Gove in Arnhem Land, Northern Territory. Nabalco is the managing company of the joint venture of Swiss Aluminium Australia Pty., Ltd. (70%), and Gove Alumina Ltd. (30%). Colonial Sugar Refining Co. is majority shareholder of Gove Alumina. The new refinery has an initial rated annual capacity of 560,000 short tons, which is to be doubled. Bauxite reserves in the Gove area are reportedly over 250 million tons. The Gove operations and the evolution of the project were described.[3]

The plant site at Upper Swan in the suburbs of Perth, where Pacminex, Pty., a subsidiary of Colonial Sugar Refining had planned to construct an alumina plant, was vetoed by the Government for environmental reasons. A new plant site at Muchea, 30 miles north of Perth, was subsequently agreed upon. This Pacminex venture was reported to include Hanwright Minerals, Ltd., and Metals Miniere, Ltd.

Brazil.—Since 1969, Mineração Rio do Norte, S.A., a subsidiary of Alcan Aluminium Ltd. (Alcan), has been developing deposits of several hundred million tons of low-silica bauxite between the Amazon and Trombetas Rivers. Alcan announced deferment of the project in mid-July, but by December 1972 Alcan signed an agreement with Companhia Vale do Rio Doce

[3] Metal Bulletin Monthly. Bauxite the Life History of Gove. No. 22, October 1972, pp. 38–41.

(CVRD) for a joint study of the project. Since previous geologic examination has confirmed the existence of sufficient reserves of good quality bauxite close to navigable river transportation, the principal problems will be markets and financing. Other large bauxite deposits are indicated south of Belem in the Paragominas region.

Cameroon.—Economic and technical studies of the bauxite deposits near Minim-Martap in the Adamawa Range were being conducted by Société d'Etudes des Bauxites du Cameroun (SEBACAM), an association formed by the Government, Péchiney Ugine Kuhlmann (PUK), Kaiser Aluminum and Chemical Corp., and Vereinigte Aluminium Werke. The studies, which were to be completed by 1974, will report on the feasibility of a large-scale bauxite exporting enterprise and the possibility of producing alumina. Estimates of reserves in the Minim-Martap area have been on the order of 1 billion tons. The deposits are about 350 miles inland from the coast near a section of the Trans-Cameroon Railway scheduled for completion by 1975. The studies will include evaluation of the various possibilities for transporting the ore, the selection and construction of a deep-water port, and the development of the bauxite deposits. The geological field work was reported to have been completed.

Canada.—Alcan installed a new dryer circuit at its Arvida, Quebec, facilities for the production of 100,000 tons per year of alumina hydrate. Most of the hydrate was expected to be used in fire retardant carpet backing.

China, Peoples Republic of.—Trade reports indicated that the People's Republic of China was increasing its exports of calcined refractory-grade bauxite. The material was believed to contain alumina mainly as the mineral diaspore, and iron specifications were quoted at a maximum of 2% Fe_2O_3.

Fiji.—Bauxite Fiji Ltd., owned by three Japanese aluminum producers, continued construction of bauxite producing facilities on the island of Vanua Levu. Initial bauxite shipments, which had been scheduled for the second half of 1972, were postponed because of construction delays.

Ghana.—In June, The Government issued a license to prospect the bauxite deposits near Kibi to Bauxite Alumina Study Co., Ltd., (Bascol). Bascol was owned by Kaiser (50%), Reynolds Metals Co. (30%), and Aluminum Resources Development Co. (Ardeco) (20%). Ardeco is a consortium of five Japanese aluminum companies. Reynolds withdrew from Bascol at the end of the year. The initial studies begun in 1972 were to determine whether a full feasibility study of a bauxite-alumina complex should be undertaken.

The Government announced its intention to obtain 55% participation in foreign mining investments. The new program presumably would apply to the operations of British Aluminium Co., Ltd., at Awaso, the only active bauxite mines in Ghana, and to any new bauxite mining ventures.

Greece.—A new concentrator for low-grade bauxite was put onstream by Bauxites Parnasse S.A. on June 25 at Itea. The new plant will treat low-grade bauxite previously considered uneconomic by extracting limestone and clay impurities from the ore. The process will make possible large-scale underground operations. Over $15 million have been spent, and about $7 million are allocated to finish the expansion program. The company's bauxite reserves are estimated at about 500 million tons.

Aluminium de Grèce S.A. reportedly was increasing its alumina production capacity about 6% through an $8 million plant expansion. Aluminium de Grèce acquired the assets of the Bauxitai Distomon S.A. mining company, reported to have extensive bauxite reserves.

PUK announced intentions to build a 1-million-ton-per-year alumina plant in Greece which would be independent of Aluminium de Grèce (90% owned by PUK). A preliminary agreement was reached between Alcoa and the Greek Government for construction of a new complex with initial annual capacities of 330,000 tons of alumina and 165,000 tons of aluminum metal. Plans for financing by the U.S.S.R. of a 495,000-ton-per-year alumina plant were announced by a group of local businessmen. The Soviet Government would take the total plant output for 7 years to retire the loan.

Early in 1972 the Greek Government announced a bauxite export quota of 1,275,000 tons, down 20,000 tons from the quota for 1971. The principal quotas set were: European Economic Community, 420,000 tons; U.S.S.R., 450,000 tons; Great Britain, 100,000 tons; United States, 75,000 tons; Japan, 20,000 tons; Czechoslovakia, 20,000 tons; Sweden, 70,000 tons; Spain, 60,000 tons.

Guinea.—Bauxite and alumina were produced by Compagnie International pour la Production de l'Alumine (FRIA), an international consortium in which Olin Corp. is the largest shareholder.

Guinea Bauxite Co. (CBG) continued construction of mining and ore preparation facilities and infrastructure for the Boké bauxite project. CBG is owned by the Government of Guinea (49%) and Halco Mining, Inc. (51%), a consortium consist-

Table 19.—World producers of alumina

(Thousand short tons)

Country, company, and plant location	Capacity, yearend 1972	Ownership
NORTH AMERICA		
Canada: Aluminum Company of Canada, Ltd., Arvida	1,387	Alcan Aluminium Ltd. 100%.
United States (see table 6)	7,760	
Jamaica:		
Alcan Jamaica Ltd.:		Alcan Aluminium Ltd. 100%.
Ewarton	613	
Kirkvine	613	
Alumina Partners of Jamiaca, Ltd., Nain, St. Elizabeth	1,300	Reynolds Metals Co. 36.8%, Anaconda Aluminum Co. 36.8%, Kaiser Aluminum & Chemical Corp. 26.4%.
Revere Jamaica Alumina, Ltd., Maggotty	220	Revere Copper & Brass Inc. 100%.
Aluminum Co. of America (Alcoa), Woodside	551	Self 100%.
Total North America	12,444	
SOUTH AMERICA		
Brazil:		
Alumínio Minas Gerais, S.A., Saramenha, Minas Gerais	66	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	55	Aluminum Co. of America 50%, Hanna Mining Co. 23.5%, Brazilian interests 26.5%.
Guyana: Guyana Bauxite Co., MacKenzie	385	Government 100%.
Surinam: Surinam Aluminum Co., Paranam	1,323	Aluminum Co. of America 100%.
Total South America	1,939	
EUROPE		
Czechoslovakia: Ziar, Banskobystricky	110	Government 100%.
France:		
Péchiney Ugine Kuhlmann Group:		Self 100%.
Gardanne	720	
Salindres	290	
La Barasse	330	
Germany, East: V.E.B., Lautawerke	70	Government 100%.
Germany, West:		
Gebrueder Giulini G.m.b.H., Ludwigshafen	143	Self 100%.
Martinswerke G.m.b.H. für Chemische und Metallürgische Produktion, Bergheim/Erft	420	Swiss Aluminium Ltd. (Alusuisse) 99.2%.
Vereinigte Aluminium-Werke A.G.:		Government 100%.
Lippenwerke, Lünen	375	
Nabrewerke, Schwandorf	231	
Greece: Aluminium de Grèce S.A., Distomon	529	Péchiney Ugine Kuhlmann group 90%, Government 10%.
Hungary:		
Almasfuzito, Ajka, Magyarovar	625	Government 100%.
Italy:		
Montecatini-Edison S.p.A., Porto Marghera	231	Self 89%, Government 11%.
Eurallumina S.p.A., Sardinia	661	Alsar S.p.A. 41.67%, Comalco 20%, Metallgesellschaft A.G. 17.5%, Montecatini-Edison S.p.A. 20.83%.
Romania: Romanian Aluminium, Oradea	231	Government 100%.
United Kingdom:		
The British Aluminium Co., Ltd.:		Tube Investments, Ltd. 52%, Reynolds Metals Co. 48%.
Burntisland	110	
Newport	44	

Table 19.—World producers of alumina—Continued

(Thousand short tons)

Country, company, and plant location	Capacity, yearend 1972	Ownership
EUROPE—Continued		
U.S.S.R.:		Government 100%.
Achinsk, Bogsitogorsk, Kirovabad, Pikalevo, Volkhov-Tikhiun, Zaporozhye, Kamensk-Uralsky, Krasnoturinsk, Pavlodar, Sumgait, Volgograd	e 3,300	
Yugoslavia:		Government 100%.
Titograd	220	
Kidricevo	154	
Total Europe	8,794	
AFRICA		
Guinea: Compagnie International pour la Production de l'Alumine (FRIA), Kimbo	772	Olin Corp. 48.5%, Péchiney 26.5%, British Aluminium 10%, Alusuisse 10%, Vereinigte Aluminium 5%.
Total Africa	772	
ASIA		
China, People's Republic of:		Government, 100%.
Kweyang, Weinan, Nanting, Fushun, Antung, Kunming, Yangshuan, Sian	e 330	
India:		
Aluminium Corp. of India, Ltd., Jaykagnagar, West Bengal	28	Self 100%.
Hindustan Aluminium Corp. Ltd., Rennkott, Uttar Pradesh	182	Kaiser 27%, Birla and Indian interests 73%.
Indian Aluminium Co. Ltd.:		Alcan 65%, Government 35%.
Muri, Bihar	85	
Belgaum, Mysore	103	
Madras Aluminium Co. Ltd., Coimbatore, Madras	55	Montecatini-Edison 27%, Madras State Government 73%.
Japan:		
Nippon Light Metal Co. Ltd.:		Alcan 50%, Japanese interests 50%.
Shimizu	577	
Tomakomai	397	
Showa Denko K.K., Yokohama	600	Self 100%.
Sumitomo Chemical Co., Ltd., Kikumoto	844	Self 100%.
Mitsui Alumina Co., Wakamatsu	220	Mitsui group 98.5%, other Japanese interests 1.5%.
Taiwan: Taiwan Aluminium Corp., Kaohsiung, Takao	84	Government 100%.
Total Asia	3,505	
OCEANIA		
Australia:		
Comalco Ltd., Bell Bay, Tasmania	65	Conzinc Riotinto of Australia, Ltd. 45%, Kaiser 45%, public 10%.
Queensland Alumina Ltd., Gladstone	1,428	Kaiser 37.3%, Alcan 22%, Péchiney 20%, Comalco 11.3%, Conzinc Riotinto of Australia 9.4%.
Nabalco Pty. Ltd., Gove	560	Swiss Aluminium Australia Ltd. 70%, Gove Alumina Ltd. 30%.
Alcoa of Australia (W.A.)N.L.:		Aluminum Co. of America 51%, Australian interests 49%.
Kwinana	1,378	
Pinjarra	463	
Total Oceania	3,894	
Total world	31,348	

e Estimate.

ing of Alcoa (27%), Alcan (27%), Martin Marietta Aluminum, Inc. (20%), PUK (10%), Vereingte Aluminium Werke A.G. (10%), and Montecatini-Edison S.p.A. (6%). The first shipment of bauxite has been rescheduled for the second half of 1973. Shipments were expected to be made initially at the rate of 4.7 million tons per year and increase to 8 million tons by the third year. The railroad from the mining site at Sangaredi to the port town of Kamsar has been completed. Three drying kilns and facilities for calcining abrasive-grade bauxite are located at Kamsar. At yearend CBG was attempting to raise $60 million in bonds and notes for the Boké project. This would increase the total funds made available for Boké to over $320 million, including $73.5 million in World Bank loans.

The Government, with assistance from the U.S.S.R., was developing a bauxite deposit at Debele in the Kindia region. Reserves were estimated at 44 million tons. The project included construction of a railway link for transporting the bauxite to Conakry, and shipments to the U.S.S.R. were expected to begin by the end of 1974.

Guyana.—The Government-owned Guyana Bauxite Co. (Guybau) closed its alumina plant for 7 weeks during the summer of 1972 because of market conditions. Sales of better than 250,000 tons of alumina included about 100,000 to the U.S.S.R. and 30,000 to the People's Republic of China. The first full year of production since the facilities were nationalized in 1971 was regarded as satisfactory by Guybau, considering the weak world market for metallurgical-grade bauxite and alumina.

Hungary.—Bauxite exports were estimated at 700,000 tons in 1972. As part of Hungary's long-term plans for expansion of its bauxite and alumina production, a new mine was opened in the Halimba area north of Lake Balaton in the Bakony Range. Reported to be the largest and deepest bauxite mine in central Europe, the new mine is expected to reach an annual production rate of 600,000 tons by 1973.

A new alumina plant, the second at Ajka, began production in 1972 and was expected to operate at an annual capacity of 265,000 short tons by the end of 1973. Planned alumina production for Hungary in 1973 is 770,000 tons (compared with 294,000 tons in 1965).

India.—Construction of the 220,000-ton-per-year alumina plant at Korba, Madhya Pradesh, being built by the Government-owned Bharat Aluminium Co., was reportedly delayed by shortages of steel and imported equipment. The plant was 90% completed at yearend, and the new date for initial production was April 1973.

Indonesia.—P.T. Alcoa Minerals of Indonesia continued exploration of the potentially important deposits it has located in southwest Kalimantan (Indonesian Borneo).

Italy.—The construction of a 660,000-ton-per-year alumina plant in Sardinia for Eurallumina S.p.A. was substantially completed. Deliveries of bauxite from Weipa, Australia, began in July 1972, and the first shipments of alumina from the new plant were expected in the first half of 1973. Eurallumina is owned by Alsar S.p.A. (41.67%), Montecatini-Edison (20.83%), Comalco (20%), and Metallgesellschaft A.G. (17.5%).

Jamaica.—Although the bauxite mines and alumina plants in Jamaica were operated below rated capacities in 1972 because of a continued oversupply of aluminum on world markets, alumina production was increased 18%. This increase, when compared with only a slight increase in bauxite production, reflected a trend to process a larger percentage of the bauxite in Jamaica.

Alcoa's new alumina plant in Clarendon Parish came onstream at an annual rated capacity of 550,000 short tons. Alumina Partners of Jamaica, Ltd. (Alpart), owned by Anaconda, Reynolds, and Kaiser, completed the expansion of its alumina plant at Nain, St. Elizabeth Parish, to a capacity of 1.3 million tons.

A national Bauxite Commission was created to insure that Jamaica's large bauxite resources are developed for the maximum benefit to the country.

Japan.—According to the Japanese Light Metal Smelters Association, suppliers' exports of bauxite to Japan increased 16% in 1972 as follows:

Supplier	Quantity (thousand long tons) 1971	1972
Australia:		
Comalco Ltd	2,186	2,177
Nabalco Pty. Ltd. (Gove)	78	534
Indonesia: P.N. Aneka Tambang	895	1,089
Malaysia:		
Ramunia Bauxite Co	258	220
Southeast Asia Bauxites, Ltd	451	475
Total	3,868	4,495

Nippon Light Metal Co., Ltd., put into operation its 397,000-short-ton-per-year alumina plant at Tomakomai, Hokkaido. Initial production was delayed until plans for offshore disposal of the red mud from the plant were changed to a disposal site on land. Mitsui Alumina Co. began production at its 220,000-ton-per-year Wakamatsu alumina plant, Kyūshū, using bauxite from Gove, Australia. The capacity of the plant was to be doubled by 1975. Chofu Alumina Co., formed by Mitsui Mining and Smelting Co. Ltd. and Ardeco, a consortium of Japanese primary aluminum producers, postponed until at least 1975 plans for completion of a 550,000-ton-per-year alumina plant to use bauxite from the Solomon Islands (British).

A joint venture, composed of Alcoa (75%) and Morimura Bros., Inc. (25%), was formed to construct facilities by 1974 to produce tabular alumina for use as a refractory material.

Solomon Islands (British).—Mitsui Mining and Smelting Co. of Japan continued the development of bauxite deposits on Rennell Island. Initial shipments to Japan were expected to begin in 1973. Conzinc Riotinto of Australia, Ltd., continued exploration of bauxite deposits on Wagina Island. The Wagina bauxite occurs as a fine-grained clayey material high in moisture. Reserves were expected to total 30 million long tons.

Surinam.—Early in March the Billiton Mine Workers Union struck the Billiton mine for higher wages for the 1,500 workers. The strike had little effect on total production for the year.

Reynolds Metals Co. continued its exploration for bauxite in the Bakhuys Mountains in western Surinam. Until such time as the company can show 50 million tons of commercial grade bauxite, Surinam was not expected to proceed with building the railroad from the deposit to the port of Apoera on the Corantijn River.

Exports of bauxite were down 3% for the year, but exports of alumina were up 9% over the quantity in 1971.

Taiwan.—The Government-owned Taiwan Aluminium Corp. (Talco) imported its bauxite supply from Malaysia and Australia. Talco planned to expand its alumina production capacity to 154,000 short tons by 1975.

Turkey.—Construction of an alumina plant at Seydişehir about 180 miles south of Ankara was expected to be completed in 1973. The plant will have a capacity of 220,000 short tons and will use bauxite from depots near Akseki in the western Taurus Mountains, where reserves have been estimated at 30 million tons.

Yugoslavia.—An agreement was reported to have been signed between the U.S.S.R. and the Yugoslav enterprise Energoinvest to develop bauxite mines in Bosnia-Hercegovina and to construct a 660,000-ton-capacity alumina plant at Zvornik. The total cost of the venture was estimated at $200 million. The U.S.S.R. will provide $130 million in credit, which will be repaid in alumina and bauxite. Production from the mines, located at Vlasenica, Jajce, and Bosanska Krupa, are to be increased to over 2.5 million tons by 1976.

TECHNOLOGY

Alunite, a hydrous potassium aluminum sulfate mineral, continued to be investigated as a commercial source of alumina in the United States. The only known commercial-size plant is operating in the U.S.S.R., at Sumgait, near the Caucasus mountains. A new process to recover fertilizers and either aluminum salts or alumina from alunite reportedly was developed in Mexico in 1971 and was expected to be used in a small plant to be built at Salamanca.

In this process the potassium in alunite was dissolved for 10 to 15 minutes in a weak basic solution such as aqueous ammonia and recovered for fertilizer use. The residue, containing the alumina, was treated successively with a weak acid and a strong acid, forming a basic aluminum salt and alumina trihydrate, which was filtered and calcined. Aluminum recoveries at a 5-ton-per-day pilot plant reportedly ranged between 90% and 92%.[4]

A joint venture of Earth Sciences, Inc., National Steel Corp., and Southwire Co., continued field investigations of alunite deposits at the southern end of the Wah Wah Mountains in Beaver County, Utah. The companies reportedly controlled indicated and inferred reserves of over 680 million tons of alunite-bearing rock in the area, containing over 40% alunite, equivalent to 100 million tons Al_2O_3, and had interests in other alunite properties in Utah, Colorado, Arizona, and Nevada. The joint venture was investigating a proprietary process to recover alumina and potassium sulfate from alunite, believed to be similar to the process that was under development in Mexico.

Based on present alumina plant capacities, a commercial plant utilizing alunite probably would require a deposit containing 50 million tons of alunite, equivalent to 8 million tons of alumina. Since there has been no domestic commercial use of alunite as a source of alumina, little information on reserves was formerly available.

Anorthosite, an aluminum silicate mineral, also was being considered as a possible alternate source of aluminum. Alcoa purchased an 8,000-acre deposit of anorthosite containing about 28% alumina, in Wyoming and continued to study ways to recover aluminum from such material. The Bureau of Mines released two reports on its investigations of dawsonite, a sodium-aluminum carbonate mineral which occurs in Colorado oil shale deposits and is a potential source of aluminum.[5]

Results of studies of the mineralogy, geochemistry, geology, and genesis of bauxite deposits throughout the world were published.[6]

Nikkei Sangyo, a subsidiary of Nippon Light Metals Co., was starting up the worlds first commercial plant using red mud to produce a substitute for fluorspar in making steel.[7] Red mud is a solid waste generated in producing alumina from bauxite. About 1 ton of red mud is generated for each ton of alumina produced. At most alumina plants red mud is impounded in red mud lakes and represents a loss of space as well as of sodium and aluminum values.

Kaiser Aluminum & Chemical Corp. developed a method for handling red mud from its Baton Rouge and Gramercy alumina plants in Louisiana in lieu of dumping it in the Mississippi River. The mud will be transported by pipeline from the alumina plants to storage areas on company property where it will be poured over a layer of river sand and dewatered. The resulting alkaline solution will be pumped back to the alumina plant and recycled. The dewatered red mud will then be covered with topsoil and planted or removed from the site and used as landfill and for other purposes.

The red mud treatment system at both plants was expected to be completed by mid-1975 and cost in excess of $25 million.[8]

---

4 Parkinson, G. Low-Grade Alunite Yields Alumina and Fertilizers Too. Chem. Eng., v. 78, No. 9, Apr. 19, 1971, pp. 83–85.

5 Smith, J. W., T. N. Beard, and P. M. Wade. Estimating Nahcolite and Dawsonite Content of Colorado Oil Shale From Oil-Yield Assay Data. BuMines RI 7689, 1972, 24 pp.

Jackson, J., Jr., C. W. Huggins, and S. G. Ampian. Synthesis and Characterization of Dawsonite. BuMines RI 7664, 1972, 14 pp.

6 Valeton, I. Bauxites. Developments in Soil Science 1. Elsevier Publishing Co., Amsterdam, London, New York, 1972, 226 pp.

7 Industrial Minerals. Interest Grows in "Red Mud" Substitute for Fluorspar. No. 60, September 1972, pp. 34, 35.

8 Metal Bulletin. Kaiser Red Mud. No. 5744, Oct. 24, 1972, p. 17.

Beryllium

By Robert A. Whitman [1]

The consumption of beryl decreased in 1972. Production of domestic ore declined, and imports were less than those of 1971. Contracts were awarded for beryllium components of the Poseidon missile system to be delivered in 1973 and 1974.

[1] Physical scientist, Division of Nonferrous Metals.

Table 1.—Salient beryllium mineral statistics

	1968	1969	1970	1971	1972 p
United States:					
Beryl, approximately 11% BeO:					
Shipped from mines ____ short tons__	168	W	W	W	W
Imports ____ do____	3,822	6,422	4,942	4,026	3,345
Consumption ____ do____	9,244	[1] 8,483	[1] 9,496	[1] 10,373	[1] 7,781
Price, approximate, per unit BeO imported, cobbed beryl at port of exportation ____	$34	$37	$35	$33	$30
Bertrandite ore: Utah, low-grade, shipped from mines ____ short tons__	--	W	W	W	W
World production of beryl ____ do____	7,242	8,869	r 6,857	5,844	4,740

p Preliminary. r Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Includes some bertrandite ore that was calculated as equivalent to beryl containing 11% BeO.

Legislation and Government Programs.—Government yearend stocks of beryl, beryllium-copper master alloy, and beryllium metal are shown in table 2. Government inventories of beryl decreased 1,602 short tons during 1972 as a result of sales.

The Environmental Protection Agency held public hearings in New York City on January 10, 1972, and in Los Angeles on February 15 and 16, 1972, to obtain testimony concerning emission standards for the three air pollutants, asbestos, beryllium, and mercury. Final emission standards are due to be published in 1973.

Table 2.—Government yearend stocks of beryllium materials

(Short tons)

Material	National stockpile	Supplemental stockpile	All stocks
Beryl (11% BeO):			
Objective ____	12,433	2,782	15,215
Excess ____	3,841	59	3,900
Total ____	16,274	2,841	19,115
Beryllium-copper master alloy:			
Objective ____	--	4,750	4,750
Excess ____	1,075	1,562	2,637
Total ____	1,075	6,312	7,387
Beryllium metal:			
Objective ____	--	150	150
Excess ____	--	79	79
Total ____	--	229	229

Source: Office of Emergency Preparedness. Statistical Supplement, Stockpile Report to the Congress OEP-4, July–December 1972.

DOMESTIC PRODUCTION

Production of beryl ore was believed to be the lowest in several years. Some beryl was produced in Colorado and South Dakota, but most mines reported assessment work only. The largest domestic source of beryllium ore was the Spor Mountain bertrandite mine near Delta, Utah. Production of beryllium-copper alloy increased, but the production of metal declined from that in 1971.

Brush Wellman, Inc. (Brush), converted bertrandite from its Utah mine to beryllium hydroxide at Delta, Utah, and shipped the hydroxide to Elmore, Ohio, for further conversion to metal, alloys, and compounds. Brush also has beryl processing facilities at Elmore.

Kawecki Berylco Industries, Inc., (KBI) used beryl for its primary ore, most of which was imported. The beryl was processed at Hazelton, Pa. Further processing and fabricating was done at both the Hazelton and the Reading, Pa., plants.

CONSUMPTION AND USES

The beryllium industry consumed beryllium ore equivalent to 7,781 short tons of beryl containing 11% BeO. There was less beryllium metal and beryllium oxide ceramics shipped in 1972 than in 1971, but there was a substantial increase in the amount of beryllium-copper master alloy shipped in 1972. Beryllium-copper alloy products consumed the largest quantity of beryllium. These alloys combine the properties of good electrical and thermal conductivity, strength, hardness, and resistance to fatigue, corrosion, and wear. They are used in an ever-increasing variety of electrical and electronic systems. Beryllium-copper also is used increasingly as a tooling material for molding plastics.

Beryllium metal is being used where a high strength-to-weight ratio is needed, as in the aerospace industry. It was used for optical structures in space, for X-ray windows, and in missile parts and nuclear structures.

Beryl Ores, Arvada, Colo., bought beryl ore to process for the ceramics industry.

STOCKS

Consumer stocks of hand-sorted beryl at the end of 1972 totaled 6,913 short tons compared with 6,299 short tons at yearend 1971. Dealers' stocks of beryl are not reported. Stocks of bertrandite are company confidential data.

PRICES AND SPECIFICATIONS

Domestic beryl prices were negotiated between producers and buyers and were not quoted in the trade press. The price of imported beryl probably was negotiated. In February the quoted price range for imported beryl was reduced as a result of the weak market to a range of $30 to $35 per short ton unit from the $35 to $37 range in January. This price range was quoted until yearend.[2]

Prices for beryllium metal products remained steady throughout 1972. Beryllium billet was quoted at $70 per pound, 98% powder prices ranged from $54 to $66 per pound, and 5-inch diameter rod at $102 per pound.

Beryllium-copper master alloy started the year quoted at $54 per pound of contained beryllium and dropped June 1 to $53 per pound, the yearend price. Casting ingot containing 2% to 2.25% beryllium in copper started at $2.10 per pound, dropped on June 1 to $2.06 per pound, and stayed at that level the remainder of the year. The quoted price for Alloy 25 was $3.14 per pound until June 1 and dropped to $3.05 per pound through yearend.

[2] Metals Week. V. 43, Nos. 1–52, January-December 1972.

FOREIGN TRADE

Exports of beryllium alloys, waste, and scrap more than doubled, but the total value decreased by 20%.

Imports of beryl decreased for the third consecutive year and were down 17% from 1971. Value per ton was down by 10%. About 84% of the beryl came from Brazil, the Republic of South Africa, and Argentina, with Brazil furnishing over one-half of the imports. In addition to the imports of beryl, there were nearly 12 tons of beryllium products, wrought, unwrought, waste, scrap, and compounds imported with a value of $286, 922.

Table 3.—U.S. exports of beryllium alloys, wrought or unwrought and waste and scrap [1]

Country	1971 Pounds	1971 Value (thousands)	1972 Pounds	1972 Value (thousands)
Australia	87	(2)	1,270	$5
Belgium-Luxembourg	--	--	3,660	2
Brazil	--	--	1,208	4
Canada	495	$45	8,175	56
France	5,560	171	23,181	83
Germany, West	2,453	31	1,105	19
India	2,499	2	6	1
Israel	600	67	--	--
Italy	28	5	3	1
Japan	6,658	126	34,025	352
Mexico	--	--	271	1
Netherlands	244	2	185	2
Norway	12,000	12	14,141	20
Philippines	--	--	1,447	5
Spain	--	--	11	1
Switzerland	760	4	1,963	23
Taiwan	--	--	156	1
United Kingdom	9,730	586	4,685	263
Total	41,114	1,051	95,492	839

[1] Consisting of beryllium lumps, single crystals, powder, beryllium-base alloy powder; beryllium rods, sheets, and wire.
[2] Less than ½ unit.

Table 4.—U.S. imports for consumption of beryl, by customs district and country

Customs district and country	1971 Short tons	1971 Value (thousands)	1972 Short tons	1972 Value (thousands)
Philadelphia district:				
Angola	--	--	56	$13
Argentina	248	$84	248	74
Australia	59	22	81	24
Brazil	2,342	889	1,755	576
Congo (Brazzaville)	23	7	23	7
Kenya	88	32	--	--
Malagasy Republic	16	5	40	13
Mozambique	163	55	--	--
Portugal	11	4	--	--
Rhodesia, Southern	--	--	65	20
Rwanda	120	36	88	23
South Africa, Republic of	593	222	798	298
Uganda	224	67	98	26
Total	3,887	1,423	3,252	1,074
New York City District:				
Angola	--	--	55	15
Australia	21	7	16	5
Brazil	23	10	--	--
Congo (Brazzaville)	23	7	--	--
South Africa, Republic of	--	--	22	7
Spain	4	1	--	--
Total	71	25	93	27
Baltimore district: Brazil	47	19	--	--
Detroit district: Canada	17	6	--	--
Norfolk district: Australia	4	2	--	--
Grand total	4,026	1,475	3,345	1,101

WORLD REVIEW

Australia.—A new beryl mine was opened near Perenjori, about 200 miles northeast of Perth. Seleka Mining and Investments, Ltd., initiated a drilling program in 1972 to determine the extent of beryl mineralization and was expected to produce beryl for export.

Brazil.—There were reports from the State of Minas Gerais of new beryl reserves to be developed with a Banco Nacional de Desenvolvimento Econômico loan of $15,000.

Japan.—The Japan Society of Newer Metals announced the capacity for production of a little more than 1 short ton annually of beryllium metal by electrolytic refining. The capacity for producing beryllium oxide was nearly 80 short tons per year, mostly by the silicofluoride process. The capacity for producing beryllium copper master alloy was about 800 tons per year. Production figures for 1972 were not available. Japan imports beryl principally from Africa, Brazil, and Australia.

Table 5.—Beryl: World production by country

(Short tons)

Country [1]	1970	1971	1972 p
Argentina	333	e 330	e 300
Australia	20	78	e 200
Brazil	[2] 3,674	2,756	e 2,000
Kenya	4	--	--
Malagasy Republic	57	66	e 50
Mozambique	36	14	e 30
Portugal	15	17	e 20
Rhodesia, Southern e	100	100	65
Rwanda	315	214	e 100
South Africa, Republic of	355	541	275
Uganda	405	244	e 120
U.S.S.R. e	1,400	1,400	1,500
United States	W	W	W
Zaire	143	84	e 80
Total	r 6,857	5,844	4,740

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 also may have produced beryl, but mineral production of this area has not been officially reported since 1966, and no reliable information is available as a basis for estimating output since that time. India, listed as a major producer in previous editions of this table (with output estimated in the order of 1,450 short tons annually) has been deleted from the producer list because information now available indicates that little if any beryl mining has been carried out in recent years.

[2] Exports.

TECHNOLOGY

The increasing concern with environmental pollution led to increased research to develop more selective analytical methods. A routine method of analysis for ultratrace concentrations of beryllium in particulate matter collected on air and water filters was described.[3]

A report on the hydrolytic behavior of toxic metals, prepared by the Oak Ridge National Laboratory,[4] should assist in determining methods to remove beryllium from water.

A process for making high strength beryllium by hot-pressing, extruding, and upset-forging, was described.[5] Isotropic compressive yield strengths of greater than 100,000 pounds-per-square-inch were achieved.

A way to bypass the traditional brittleness of beryllium by a technique of diffusion-bonding thin sheets into a laminated plate was reported. The resulting plate had better mechanical properties than the thin sheet from which it was made, and properties substantially superior to sheet

[3] Ross, William D., and Robert E. Sievers. Environmental Air Analysis for Ultratrace Concentrations of Beryllium by Gas Chromatography. Environmental Science and Technology, v. 6, No. 2, February 1972, pp. 155–178.

[4] Baes, C. F. Jr., and R. E. Mesmer. Ecology and Analysis of Trace Elements. Oak Ridge National Laboratory, ORNL-NSF-EATCI, March 1973, pp. 236–237.

[5] Floyd, Dennis R. Isotropic High Strength Beryllium. The Dow Chemical U.S.A., RFP 1816, July 6, 1972, 11 pp.

rolled directly from ingot to similar thickness.[6]

One paper reported efforts to improve ductility of beryllium by precipitation of about 1% iron from supersaturated solutions of iron in beryllium utilizing the Mössbauer effect.[7]

Further progress in reinforcing a titanium matrix with beryllium to improve rigidity and decrease weight of turbine fans and compressor blades resulted from work on Contract N00019-72-C-0247. This work was performed for the Department of the Navy, Naval Air Systems Command.

The need for substrates with high thermal conductivity for thin film electronic circuitry led to a study of the preparation of BeO by thermal decomposition of the sulfate phase.[8] A Brush scientist reported on the important aspects of heat-treating beryllium-copper alloys. KBI introduced a new alloy they designated Berylco 21C.

Five patents on the leaching of beryllium from its ores were noted, four from the United States and one from Canada.[9] Another U.S. patent dealt with the recovery of beryllium from low-grade ores by reacting the ore directly with anhydrous sulfur trioxide.[10]

The Bureau of Mines continued inhouse research on the casting of beryllium alloys showing promise of ductility, fracture toughness, and weldability. Castings made with a beryllium alloy containing 10% combined nickel and aluminum were very porous and had the appearance of having a high gas content. A proprietary mold from a commercial casting company and a graphite mold coated with beryllium oxide were used. Some porosity seemed to be due to mold reaction. The work was to be continued.

---

[6] Heiple, Clinton R. Mechanical Properties of Diffusion-Bonded Beryllium Ingot Sheet. Metal Trans., v. 3, No. 4, April 1972, pp. 807–812.

[7] Janot, Christian, and Huguette Gibert. Etude par Effet Mössbauer de la Précipitation du Fer dans le Beryllium (Study of the Precipitation of Iron in Beryllium by Means of the Mössbauer Effect). Materials Science and Engineering, v. 10, No. 1, July 1972, pp. 23–31.

[8] Johnson, D. W., Jr., and P. K. Gallagher. Kinetics of the Thermal Decomposition of $BeSO_4$. J. Amer. Ceram. Soc., v. 55, No. 5, May 1972, pp. 232–233.

[9] Grunig, J. K., W. B. Davis, and W. C. Aitkenhead (assigned to The Anaconda Company). Extraction of Beryllium. U.S. Pat. 3,704,091, Nov. 28, 1972; U.S. Pat. 3,685,961, Aug. 22, 1972; U.S. Pat. 3,699,208, Oct. 17, 1972; Canadian Pat. 907,286, Aug. 15, 1972.

Olson, R. S., and J. P. Surls, Jr. (assigned to The Dow Chemical Co.). Beryllium Extraction. U.S. Pat. 3,669,649, June 13, 1972.

[10] Habashi, F., R. Dugdale, and F. L. Holderreed (assigned to The Anaconda Company). Recovery of Beryllium From a Low-Grade Ore by Sulfur Trioxide. U.S. Pat. 3,650,679, Mar. 21, 1972.

Bismuth

By J. M. Hague [1]

After declining in the preceding 2 years, consumption of bismuth in the United States during 1972 increased about 40% to a level near the annual average of the 1961–70 period.

The price of bismuth was generally firm during the year but at a level substantially below the average of recent years. Sustained demand however, brought a price increase in the fourth quarter. Domestic production increased only slightly and the increased demand was met by increased imports and by sales from the Government stockpile. World production outside the United States increased slightly and reached a new record. World production and consumption of bismuth has grown at a faster rate during the last 30 years than U.S. production and consumption; the centers of production are shifting toward foreign mines and smelters.

Legislation and Government Programs.—The General Services Administration (GSA) continued to sell surplus stocks of bismuth from the national stockpile during the first three quarters of 1972. On October 10, announcement was made that all bismuth remaining in inventory was required in order to meet the stockpile objective at that time, 2.1 million pounds; the sales program was terminated under the authorization of Public Law 91–318 (approved July 10, 1970). Sales during 1972 were 235,100 pounds. The stockpile inventory at the end of the year was 2,204,733 pounds.

Bismuth remained on the list of commodities eligible for exploration assistance from the Office of Minerals Exploration (OME) covering 75% of the cost; but no contracts were in effect during 1972 and no applications were pending.

Federal income tax laws under the Tax Reform Act of 1969 provide a percentage depletion allowance of 22% for domestic production and 14% for U.S. companies producing from foreign sources.

[1] Mining engineer, Division of Nonferrous Metals.

Table 1.—Salient bismuth statistics

(Pounds)

	1968	1969	1970	1971	1972
United States:					
Consumption	2,347,768	2,531,959	2,209,641	1,648,718	2,315,534
Exports [1]	120,466	447,931	910,275	71,187	264,276
Imports, general	1,265,671	894,804	997,924	848,708	1,562,934
Price: New York, average ton lots	$4.00	$4.63	$6.00	$5.26	$3.63
Stocks Dec. 31: Consumer and dealer	621,500	597,901	[2] 721,714	[2] 1,107,215	[2] 717,466
World: Production	8,312,000	8,289,000	8,192,000	8,442,000	8,794,000

[1] Includes bismuth, bismuth alloys, and waste and scrap.
[2] Consumer stocks only.

Table 2.—Historical bismuth statistics

(Thousand pounds)

Year	World production	United States			Average annual price (dollars per pound)
		Consumption	Exports	Imports	
1937	1,543	285	900	67	1.00
1938	2,205	1,000	226	92	1.05
1939	2,866	500	314	183	1.10
1940	3,086	500	600	124	1.25
1941	3,086	NA	434	223	1.25
1942	3,748	NA	15	NA	1.25
1943	3,086	2,004	16	431	1.25
1944	2,646	1,466	10	364	1.25
1945	2,425	1,635	116	333	1.25
1946	2,205	1,330	153	422	1.44
1947	3,307	NA	241	311	1.98
1948	3,307	NA	352	300	2.00
1949	3,307	NA	191	542	2.00
1950	3,100	NA	199	782	2.06
1951	3,900	1,737	147	527	2.25
1952	3,900	1,775	245	708	2.25
1953	4,600	1,568	127	641	2.25
1954	3,700	1,439	138	644	2.25
1955	4,200	1,548	204	596	2.25
1956	5,300	1,513	287	918	2.25
1957	5,000	1,615	158	848	2.25
1958	4,600	1,243	316	637	2.25
1959	5,000	1,598	180	457	2.25
1960	5,300	1,527	157	1,167	2.25
1961	5,700	1,478	318	799	2.25
1962	6,700	1,910	351	816	2.25
1963	5,566	2,175	36	1,123	2.25
1964	6,375	2,160	61	1,238	2.30
1965	6,526	2,932	342	1,378	3.43
1966	6,861	3,199	89	1,681	4.00
1967	7,441	2,514	153	1,380	4.00
1968	8,312	2,348	120	1,266	4.00
1969	8,289	2,532	448	895	4.63
1970	8,192	2,210	910	998	6.00
1971	8,442	1,649	71	849	5.26
1972	8,794	2,316	264	1,563	3.63

NA Not available.

DOMESTIC PRODUCTION

Bismuth produced by domestic smelters or refineries is obtained principally as a byproduct from treatment of domestic and foreign lead concentrates, and from processing leady flue dusts from copper converting processes. The principal producers were American Smelting and Refining Co. (Asarco), Omaha, Neb., and UV Industries (formerly U.S. Smelting Refining & Mining Co.), East Chicago, Ind. UV Industries closed its Tooele, Utah, lead smelter in January 1972, thus shutting off the supply of western bismuth-bearing products formerly refined at the East Chicago plant. Production from UV Industries in 1972 was mostly from inventory material, and its future operations will depend on a supply of secondary lead. A small amount of metallic bismuth, about 1% of domestic production in 1972, was recovered from secondary material by United Refining & Smelting Co. at Franklin Park, Ill.

Domestic refinery production statistics are withheld to avoid disclosing individual company confidential data. Total refinery production at the three plants increased a little more than 1% above the 1971 level. Although domestic production is not revealed in tabulated world production, the U.S. usually ranks among the first six producing countries. The proportion of domestic production that comes from imported concentrates, bullion, and dusts can be estimated only roughly; it is probably no more than half.

Cerro Corp., New York, is the principal U.S.-owned foreign producer and importer. It also owns a substantial domestic consuming subsidiary, Cerro Metal Products Division. Cerro refines in Peru a large part of the bismuth-bearing ores produced from the surrounding Andean region.

CONSUMPTION AND USES

The domestic consumption of bismuth in 1972 recovered from the low usage reported for 1971 to a rate more consistent with long-range trends. Current annual consumption of 2,315,500 pounds is only slightly below the average annual consumption for 1961–70 (2,346,000 pounds).

The pharmaceutical group, including therapeutic agents, cosmetics, and industrial and laboratory chemicals continued to be the largest consuming market for bismuth products. The licensing of new plants to produce acrylic acid using a bismuth catalyst may have revived the consumption of bismuth for catalytic chemicals.

The use of bismuth in fusible alloys increased 47% over 1971 consumption as a result of increased industrial activity and a relatively low price for bismuth during the first three quarters of 1972.

Bismuth used in metallurgical applications, as an alloy to improve machinability of aluminum, steel, and malleable iron, showed a 52% increase, probably due mainly to increased production in the automotive industry.

Table 3.—Bismuth metal consumed in the United States, by use

(Pounds)

Use	1971	1972
Fusible alloys [1]	514,203	754,432
Metallurgical additivies	362,527	549,973
Other alloys	17,439	18,004
Pharmaceuticals [2]	724,592	983,877
Experimental uses	26,175	1,105
Other uses	3,782	8,143
Total	1,648,718	2,315,534

[1] Includes bismuth contained in bismuth-lead bullion used directly in the production of an end product.

[2] Includes industrial and laboratory chemicals and cosmetics.

STOCKS

Stocks of bismuth metal held by domestic consumers decreased during 1972 from 1,107,200 to 717,500 pounds. Sales of Government surplus stocks during the year by GSA amounted to 235,100 pounds. During the last quarter of 1972, sales of bismuth from the Government stockpile were discontinued because the remaining inventory was required to meet the stockpile objective. If the objective is reduced in 1973, the stockpile may again become a domestic source of bismuth.

PRICES

The price of refined bismuth as quoted by the American Metal Market remained at $3.50 per pound until October 1. An increase to $4 per pound was announced as of October 2 by Cerro Corp. and Asarco. The London Metal Exchange price for bismuth in ton lots, c.i.f., as reported by Metal Bulletin of London, was $3.20 per pound in January, $3.60 in April, $3.25 in July, $4 in October, and $4.05 on December 29. The reason given by U.S.-based producers for the price increase in October was that stocks were getting low and production was limited. Producer and dealer prices were firm at the end of the year, and the outlook was for a possible increase in price during 1973.

FOREIGN TRADE

Exports of bismuth metal, alloys, and waste and scrap went to 15 countries for a total shipment of 264,000 pounds. This was more in line with exports in previous years after the surge in 1970. Belgium received 36% of the total, United Kingdom 24%, Canada 14%, and other countries 26%.

Imports of metallic bismuth increased to 1,563,000 pounds, second only to the 1966 record amount, in order to satisfy the increased demand that grew with a relatively static domestic production and a reduced amount sold from the national stockpile. The imports of metallic bismuth were augmented by 233,000 pounds gross weight of bismuth-lead alloys from Mexico and 35,000 pounds gross weight of alloys from Peru. Bismuth compounds and mixtures were imported in the amount of 7,400 pounds from European countries, half from West Germany.

Table 4.—U.S. exports of bismuth [1]

Year	Gross weight (pounds)	Value
1969	447,931	$1,515,363
1970	910,275	2,332,423
1971	71,187	199,084
1972	264,276	492,585

[1] Includes bismuth, bismuth alloys, and waste and scrap.

Table 5.—U.S. general imports of metallic bismuth, by country

Country	1971		1972	
	Quantity (pounds)	Value (thousands)	Quantity (pounds)	Value (thousands)
Belgium-Luxembourg	40,579	$171	8,030	$32
Bolivia	--	--	1,164	4
Canada	87,985	374	47,446	163
Ecuador	--	--	20,000	94
France	--	--	6,631	19
Germany, West	--	--	42,046	141
Italy	2,216	8	--	--
Japan	228,491	1,047	191,029	596
Korea, Republic of	28,675	153	111,650	339
Mexico	251,591	1,135	238,660	666
Netherlands	15,400	78	24,280	78
Peru	191,732	1,074	478,885	1,733
South Africa, Republic of	--	--	8,000	18
United Kingdom	2,039	10	383,984	1,349
Yugoslavia	--	--	1,129	3
Total	848,708	4,050	1,562,934	5,235

WORLD REVIEW

Market conditions for bismuth improved during 1972 from the oversupply situation in 1971. World production, excluding U.S. production, increased to an estimated record high of 8.8 million pounds. Consumption in the United States increased more markedly than that in the rest of the world. Most bismuth continued to be produced as a byproduct from smelting copper, lead, molybdenum or zinc ores and concentrates and from treatment of smelter residues; however, two new smelting plants have been designed to produce bismuth as a major product, one in Bolivia, now in operation, and one in Australia, scheduled to start in 1973.

Australia.—Mine production in 1972 exceeded 830,000 pounds, produced mainly by Peko-Wallsend Ltd. from the Juno mine near Tennant Creek, Northern Territory. Ore reserves at the Juno mine are given as 170,000 tons assaying 1.95 ounces of gold per ton, 0.8% bismuth, and 0.4% copper. The Peko, Warrego, and Orlando mines of the same company were in production, but not on bismuth-bearing ores. Ore reserves at Peko are 750,000 tons assaying 0.1 ounce of gold per ton, 3.2% copper, and 0.15% bismuth; ore reserves at Warrego are 5,000,000 tons assaying 0.1 ounce of gold per ton, 2.6% copper, and 0.3% bismuth; and ore reserves at Orlando are 100,000 tons assaying 0.035 ounce of gold per ton, 5% copper, and 0.1% bismuth. Peko-Wallsend Metals Ltd., a subsidiary, has made good progress in the construction of a smelter at Tennant Creek designed to produce low-bismuth blister copper and crude-bismuth bullion. The initial operation of the plant was scheduled for March 1973 with a planned capacity of over 2,000,000 pounds of bismuth annually. Current bismuth production is shipped as concentrates to Japan at the rate of about 500,000 pounds of bismuth metal per year. The completion of the Tennant Creek smelter will probably be accompanied by an increase in mine production and will make Australia a major world source of bismuth.

Bolivia.—COMIBOL (Corporación Minera de Bolivia) opened its new bismuth smelter at Telamayu in May 1972. The plant is designed to handle 440 short tons

Table 6.—Bismuth: World mine production, by country

(Thousand pounds)

Country [1]	1970	1971	1972 p
Argentina (in ore)	(2)	e 1	e 1
Australia (in concentrates)	422	537	e 830
Bolivia	3 1,340	3 1,470	4 1,058
Canada [5]	590	267	402
China, People's Republic of (in ore) e	550	550	550
France (metal)	159	170	e 176
Germany, West (in ore) e	29	29	27
Japan (metal)	1,495	1,790	1,974
Korea, Republic of (metal)	234	214	e 210
Mexico [5]	1,259	1,257	1,387
Mozambique (in ore)	3	3	e 3
Peru [5]	1,593	1,591	1,609
Romania (in ore) e	180	180	180
South Africa, Republic of	--	(2)	--
Spain (metal)	r 27	e 26	e 26
Sweden (in ore) e	33	33	33
Uganda (in ore)	2	2	e 2
U.S.S.R. (metal) e	110	120	130
United States	W	W	W
Yugoslavia (metal)	166	202	196
Total	r 8,192	8,442	8,794

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 South-West Africa are believed to produce bismuth, but information is inadequate to make reliable estimates of output levels.
[2] Less than ½ unit.
[3] Production by COMIBOL and exports by medium and small mines.
[4] Exports by all producers.
[5] Bismuth content of refined metal and bullion, plus recoverable content of concentrates exported.

per month of concentrates to produce 150,000 pounds per month of bismuth metal or about 1,800,000 pounds per year. In the past, concentrates have been sent to Peru or Europe for smelting and refining at the rate of about 1,400,000 pounds per year; the new installation, if operated at design capacity, will increase Bolivia's contribution to world production of bismuth metal.

In November, COMIBOL announced that meetings would be held in La Paz with other international bismuth interests to establish lines of communication among producers and to form a Bismuth Institute to investigate new uses, promote growth, and keep statistics on consumption.

Canada.—Bismuth production as a byproduct of molybdenum ores in western Quebec has been curtailed by the closing of several molybdenum mines. However, increased bismuth production from lead concentrates by Cominco, Ltd., at Trail, British Columbia, and by Brunswick Mining and Smelting Corp. Ltd. at Belledune, New Brunswick, partially offset this loss so that the total bismuth production for Canada increased about 50% from the 1971 production level, although it was still below the 1970 output.

Japan.—According to preliminary estimates, Japan led the world in the production of bismuth metal in 1972. Production from its eight metallurgical plants is a byproduct of the treatment of copper, lead, and zinc ores and concentrates. Much of the Japanese production is thought to come from imported concentrates and residues, so its mine production may be only part of the reported output. The rate of production reported for several consecutive months in 1972 was about 165,000 pounds per month.

Mexico.—Most bismuth metal production in Mexico is exported after recovery from impure lead bars or bullion. The two principal producers are Asarco Mexicana, S.A., at its Monterrey refinery and Metalurgica Mexicana Peñoles, S.A., also at Monterrey. Bismuth-bearing lead bullion is also exported to the United States and the United Kingdom for further refining; roughly one-fifth of total Mexican bismuth production is sent to the United States for extraction from bullion by U.S. refiners.

Peru.—Cerro Corp. is one of the principal world suppliers of bismuth from products made by its metallurgical works at La Oroya. A major part of its production is exported and consumed in the United States. Smaller producers in Peru, as well as a few small producers in Bolivia, may ship ore and concentrates to Cerro or export them to foreign refiners.

TECHNOLOGY

A new microfilm process using a thin layer of bismuth on film was announced by Bell Laboratories.[2] A centrifugation process for removing bismuth from lead was developed by the Federal Bureau of Mines.[3] Australian research laboratories developed an electrometallurgical method for debismuthing lead.[4] The thermodynamic, thermoelectric, electrochemical and alloying behavior of bismuth was studied and reported on in several papers.[5]

[2] American Metal Market. Bismuth is Key Material in New Microfilm Process. V. 79, No. 191. Oct. 18, 1972, p. 9.

[3] Montagna, D., and J. A. Ruppert. Removing Bismuth From Lead With a Submersible Centrifuge. BuMines RI 7602, 1972, 10 pp.

[4] Commonwealth Scientific & Industrial Research Organization, Minerals Research Laboratories (Melbourne, Australia). Annual Report 1971–72. P. 22.

[5] Cadle, S. H., and S. Bruckenstein. Ring-Disk Electrode Study of the Reduction and Oxidation of Bismuth on Gold. J. Electrochem Soc., v. 119, No. 9, 1972, pp. 1166–1169.

Cochrane, G., and W. V. Youdelis. Transport and Thermoelectric Properties of Bismuth and Bi-12 At. Pct. Sb Alloy Powder Compacts. Met. Trans., v. 3, No. 11, 1972, pp. 2843–2850.

Coyle, R. J., C. Vacha, and E. A. Peretti. Constitution of the Tin-rich and Bismuth-rich Regions of the Tin-Bismuth-Arsenic Ternary System. J. Less-Common Metals, v. 26, 1972, pp. 263–272.

Ptak, W., and Z. Moser. The Thermodynamic Properties of the Zn-Sn-Cd-Bi Liquid Quaternary Solutions. J. Electrochem Soc., v. 119, No. 7, 1972, pp. 843–849.

Boron

By K. P. Wang [1]

Production and domestic consumption of boron minerals continued the rising trend begun in 1961 and reached a new high in 1972. However, recorded exports in terms of B_2O_3 content showed little overall change from 1971 and were considerably lower than the average level in 1969–70. For some time, all U.S. output had been in the form of sodium borates and boric acid. Recently, production of calcium borate (colemanite) on a commercial scale was resumed in California, which provides the entire domestic production of boron minerals.

Legislation and Government Programs.—During 1972 there were no Government programs and no legislation proposed or enacted pertaining to boron. The Government had no stocks, and no procurement programs were in effect.

The depletion allowance remained at 14% for both domestically and foreign-produced borates in accordance with the Tax Reform Act of 1969.

Table 1.—Salient boron minerals and compounds statistics in the United States

(Thousand short tons and thousand dollars)

	1968	1969	1970	1971	1972
Sold or used by producers:					
Quantity:					
Gross weight	963	1,020	1,041	1,047	1,121
Boron oxide	519	551	562	568	607
Value	$76,535	$81,261	$86,827	$89,856	$95,882
Imports for consumption:[1]					
Quantity	19	24	27	7	20
Value	$558	$718	$831	$233	$626

[1] Colemanite only.

DOMESTIC PRODUCTION

Domestic production and sales of boron increased slightly in 1972 compared with those of 1971. Most of the output came from Kern County, Calif., and to a lesser extent from San Bernardino County, Calif.

The large open pit mine of U.S. Borax & Chemical Corp., a subsidiary of the British-owned Rio Tinto Zinc Corp. Ltd., at Boron, Kern County, remained the world's foremost source of boron. U.S. Borax produced upgraded crude sodium borates, refined borates, including anhydrous borax, and boric acid, including anhydrous boric acid, at the mine site. High-purity and specialty products were produced mainly at Wilmington, Calif., and secondarily at Burlington, Iowa. Wilmington was also the company's port of export. These plants headed by the one at Boron had a combined annual capacity of more than 500,000 short tons of equivalent B_2O_3 in 1972. A 3-year, $10 million program to drastically cut down dust emissions at Boron was successfully concluded in 1972.

Kerr-McGee Chemical Corp., formerly American Potash & Chemical Co., and Stauffer Chemical Co. produced boron compounds and other products from brines of Searles Lake in San Bernardino County, Calif., at their almost-adjoining plants in Trona. Kerr-McGee's annual capacity is about 100,000 short tons of B_2O_3 and Stauffer Chemical's capacity 25,000 to 30,000 tons of B_2O_3. In the spring of 1972, Kerr-

[1] Physical scientist, Division of Nonmetallic Minerals.

McGee announced plans to build a $100 million soda ash plant along with additional borate refining facilities.

In 1972, Tenneco Oil Co. produced far less colemanite than it had originally planned from its deposit in the Furnace Creek district of Inyo County, Calif., and its nearby processing plant in Nevada. Tenneco had designed the facilities to produce 150,000 short tons of raw colemanite, or roughly 70,000 short tons of calcined colemanite, per year, but actually turned out only a fraction of this, because of difficulties in calcining. The 48% B_2O_3 grade calcined colemanite was shipped primarily to Owens-Corning Fiberglas Corp.'s plants in Anderson, S.C., and Burkette, Tenn.

Although Occidental Petroleum Corp. through its subsidiary Hooker Chemical Corp. was scheduled to become the third borate-producing company on the shores of Searles Lake before yearend 1972, a proposed plant never took shape because of excessive quantities of brines needed.

CONSUMPTION AND USES

U.S. consumption of boron materials is difficult to estimate because of the wide range of products and the large tonnages of exports in the form of both crude and finished borates. Although U.S. Borax is an international company with farflung worldwide interests, it does not disclose details on shipments to foreign countries. Kerr-McGee also exports considerable quantities of borates. Water-borne freight charges from Wilmington, Calif., to Europe are less than those to the east coast United States, because high-cost U.S. bottoms must be used in domestic runs and special low rates are possible on European runs. U.S. Borax's 20,000- to 30,000-deadweight-ton ships carrying borates to Europe often come back with Volkswagens that pay for a large part of the freight charge.

Generally speaking, about one-half of the U.S. output of boron minerals and compounds was consumed at home, and the other one-half was exported. Official U.S. trade statistics do not list crude borates as a separate category and imply that none is exported. Actually, shipments of unfinished products to foreign countries were larger than those of fully refined products.

An estimated 40% to 45% of the boron compounds consumed were used in manufacturing various kinds of glasses within the United States. Boron materials account for 5% to 10% of many special glasses by weight and 50% to 75% by value. About 15% of all boron consumed went into insulating fiber glass, 10% into textile fiber glass, and 15% to 20% into all other glasses. The manufacture of enamels, frits, and glazes for protective and decorative coatings on sinks, stoves, refrigerators, and many other household and industrial appliances accounted for another 10% of the boron consumption.

Approximately 15% of the boron compounds consumed in the United States, (about one-third in the form of sodium perborate detergents), went into soaps and cleansers during 1972. Herein lies one major difference in U.S. and European consumption patterns. In Europe, sodium perborate detergents, used primarily in high-temperature washing, account for more than one-quarter of the boron consumed whereas in the United States, consumption for cleansers is higher. Borax and boric acid are used in the cleansing field because of their bactericidal characteristics, easy solubility in water, and excellent water-softening properties. They also go into toothpaste, mouthwash, and eyewash.

Borax added to fertilizers to supply boron as an essential plant nutrient accounted for about 5% of the U.S. boron demand. Another 2% to 3% went into the making of herbicides. Substituting colemanite for fluorite in steelmaking did not progress beyond the pilot plant stage.

About one-fourth of the boron consumed in the United States went into many miscellaneous uses. Minor amounts of boron compounds were used as fluxing materials in welding, soldering, and metal refining. Some elemental boron was used as a deoxidizer in nonferrous metallurgy, as a grain refiner in aluminum, as a thermal neutron absorber in atomic reactors, in delayed action fuses, as an ignitor in radio tubes, and as a coating material in solar batteries. Use of boron compounds in abrasives gained ground, particularly cubic boron nitride produced by synthetic diamond producers. Use of boric acid as a catalyst in the air oxidation of hydrocarbons accounted for more than 3% of the boron consumption. Boron materials went into many other areas, including direct consumption in chemicals, conditioning agents or precursors to chemicals, plasticizers, adhesive additives for latex paints, fire retardents, antifreeze, textile and paper products, biocides in jet fuels, photography, and composite materials.

PRICES

Prices of virtually all borate products at yearend 1972 were the same as the prices posted for yearend 1971. Elemental boron prices were quoted at yearend 1972 by the American Metal Market as follows, per pound, in ton lots: 90% to 92% $13; 97% to 99% $18; and over 99%, $70. Prices of various boron compounds are shown in table 2.

Table 2.—Prices of boron compounds at yearend, 1972

	Price per short ton [1]
Borax, technical:	
Anhydrous, 99%:	
Bags	$113.00
Bulk	103.25
Granular, decahydrate, 99.5%:	
Bags	64.75
Bulk	56.25
Granular, pentahydrate, 99.5%:	
Bags	83.75
Bulk	75.25
Boric acid, technical:[2]	
Anhydrous, 99.9%, bags [3]	197.00
Crystals, 99.9%, bags	253.00
Granular, 99.9%, bags	138.00
Sodium borate powder, U.S.P., bags	117.25

[1] Carlots, f.o.b. plant works.
[2] Technical boric acid, $33 per ton higher in drums.
[3] Anhydrous and granular $10 to $12 per ton lower in bulk.

Source: Chemical Marketing Reporter and industry sources.

FOREIGN TRADE

U.S. exports of boric acid were 27,655 short tons (valued at $4.2 million) in 1972, compared with 36,409 tons in 1971. Exports of refined sodium borate showed little change—162,123 tons (valued at $18.3 million) in 1972 and 166,087 tons in 1971. The overall level of exports of all the refined boron compounds was therefore about the same during the last 2 years and considerably below the average level during 1969–70. As noted, these figures hardly tell the whole story since exports of crude borates were actually higher than exports of refined borates.

Detailed breakdown of the recorded exports in 1972, namely boric acid and refined sodium borate, are shown in table 3. Within this table, data for all countries outside Western Europe are accurate. The problem for Western Europe is that the Netherlands distorts the total because this country is primarily a transshipment point for boron compounds to other nearby countries. A more meaningful estimate embracing crude borates as well would show that West Germany, the United Kingdom, France, and Japan were the ranking final export destinations, in that order, and the Netherlands was actually eighth in 1972.

In 1972, the United States imported 20,227 short tons of calcium borate (colemanite) valued at $626,000, all from Turkey. This tonnage was of nearly the same magnitude as the average imports during 1968–70 and approximately three times the 1971 imports.

Table 3.—U.S. exports of boric acid and sodium borates, in 1972

Destination	Boric acid (H_3BO_3 content) Short tons	Boric acid (H_3BO_3 content) Value (thousands)	Sodium borates (refined) Short tons	Sodium borates (refined) Value (thousands)
Australia	2,446	$379	4,341	$424
Belgium-Luxembourg	--	--	279	22
Brazil	1,109	201	2,221	268
Canada	3,796	494	11,251	1,152
Chile	174	32	471	61
Colombia	626	105	715	75
Costa Rica	33	6	281	30
El Salvador	3	1	295	87
Finland	--	--	729	96
France	--	--	1,956	217
Germany, West	1,668	230	737	79
Guatemala	10	2	243	78
Hong Kong	206	31	3,634	441
Indonesia	22	3	1,066	91
Israel	--	--	623	62
Italy	49	11	59	3
Japan	9,516	1,367	34,422	3,767
Korea, Republic of	447	72	2,410	205
Malaysia	43	8	287	28
Mexico	2,109	315	8,494	882
Netherlands	1,455	325	71,378	8,408
New Guinea	470	77	139	17
New Zealand	426	67	2,486	410
Nicaragua	11	2	189	61
Pakistan	167	26	--	--
Peru	162	29	375	38
Philippines	558	84	870	102
Singapore	85	16	206	23
South Africa, Republic of	86	15	1,271	190
Spain	--	--	298	36
Sweden	105	15	292	18
Switzerland	--	--	196	16
Taiwan	510	75	3,034	298
Thailand	241	46	1,322	139
United Kingdom	353	39	880	57
Venezuela	273	51	586	63
Vietnam, South	283	42	2,207	164
Yugoslavia	--	--	617	70
Other	213	41	1,263	145
Total	27,655	4,207	162,123	18,323

WORLD REVIEW

Argentina.—Argentina's output of sodium borates has increased from about 23,000 short tons in 1968 to more than 50,000 tons in 1972, but overall potential is far from extensive. Ores mined in the Andes are trucked from Tincalaya to Quijano in the lowlands for processing. The principal producer, Boroquimica Limitada, is another subsidiary of Rio Tinto Zinc Corp. During 1970–71, recorded exports of processed borates from Argentina were about 12,000 tons per year, mainly to Brazil.

China, Peoples Republic of.—Large resources of borates are claimed by the Chinese, particularly for the Iksaydam dried lake area of Tsinghai Province. The textile fiber glass industry in China, which consumes considerable borates, has been expanded sharply in recent years. For some time now, China has shipped a few thousand tons of surplus borates annually to Japan.

Turkey.—Turkey's 1972 output of boron minerals registered another increase over the 629,000 short tons of 39% B_2O_3 grade crude product reported for 1971. Virtually all of this was colemanite, as the extensive deposits of sodium borates have not yet been developed. The output was shipped mainly in the crude form to refineries in Europe. Approximately one-half of Turkey's 1970–72 colemanite production was accounted for by the Government-owned Etibank, which announced the completion of a 600,000-ton concentrator in the Kirka area in mid-1972.

The nationalization issue was not yet resolved by yearend so that the three existing private producers of borates headed by

Rio Tinto Zinc Corp.'s subsidiary Türk Boraks Madençilik Co. were still operating independently. A new coalition government under Feret Melen, in power since the spring of 1972, has introduced a bill in parliament concerning nationalization which was still pending at yearend. With a 50–50 chance of passage, the bill stipulates that boron would be one of four major mineral industries to be nationalized and private owners would be compensated according to "book value."

TECHNOLOGY

Use of colemanite as a substitute for fluorspar in the basic oxygen furnace steel process did not make any headway beyond the testing stage.

In the field of cement manufacture, it was claimed that the addition of 1.5% to 2.5% by weight of boron trioxide in the form of boric acid, calcium tetraborate, or crude colemanite to the raw mix results in a more easily grindable clinker and ultimately a stronger cement.

Boron was being investigated by the U.S. Air Force as part of a fluidized-solids propellant mixture to be used in aerospace rockets.[2] The propellant would consist mainly of fluidizing gas with solids representing only about 1% of the weight.

Use of boron and titanium in grain refining of aluminum and its alloys was discussed.[3]

Less expensive ways for producing boron nitride for abrasives were being investigated.

[2] Chemical Engineering. May 15, 1972, p. 54.
[3] Metallurgical Transactions. V. 3, No. 8, August 1972, pp. 2290–2292.

Bromine

By Charles L. Klingman [1]

The bromine industry displayed surprising vitality in 1972. In spite of efforts to reduce atmospheric pollution from automobile exhausts, the predicted reduction in use of tetraethyl lead as an antiknock and ethylene dibromide as a lead scavenger in gasoline did not occur. There was, in fact, an increase of more than 13% in ethylene dibromide production in the United States, compared with that of 1971. The increase was caused, to some extent, by increased exports of antiknock compounds, which include ethylene dibromide particularly to the United Kingdom and Brazil.[2] In 1972 total bromine production increased by 30,918,000 pounds over 1971 production. It is probable, however, that the large 1972 gain will not be maintained in 1973 and subsequent years.

DOMESTIC PRODUCTION

The State of Arkansas continued to gain in bromine production, with 1972 output about 17% above that of 1971. Michigan had a 6.6% reduction in output. The high bromine concentration and large reserves of Arkansas underground brine makes this State a logical location for future expansion. The brine wells of Michigan, by comparison, were not as free-flowing and had lower bromine content. Therefore, more wells had to be drilled and more brine had to be handled in Michigan per pound of bromine produced.

About 10% of the total bromine produced was sold in the elemental state to nonmanufacturers of bromine compounds. The fraction of the bromine production not used in the manufacture of compounds had remained relatively constant over the years.

The rate of bromine production in 1972 was 9% higher than that of 1971. The historic growth rate for the industry was about 7% per annum.

Table 1 presents data only on elemental bromine. The bromine classified as "used" in table 1 is the same bromine that appears in table 2 as the "bromine content" of manufactured compounds, except for processing losses and variations in stocks on hand. Table 2 deals exclusively with bromine compounds manufactured for the end use market.

In 1972 there were 10 bromine producing plants in three States operated by

[1] Physical scientist, Division of Nonmetallic Minerals.
[2] Chemical Engineering News. Surprise Comeback for Antiknock Compounds. V. 50, No. 47, Nov. 20, 1972, p. 6.

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)

	1971		1972	
	Quantity	Value	Quantity	Value
Sold	33,295	6,074	37,402	6,343
Used	322,651	55,676	349,462	57,346
Total	355,946	61,750	386,864	63,689

Table 2.—Bromine compounds sold by primary producers in the United States

(Thousand pounds and thousand dollars)

	1971			1972		
	Quantity		Value	Quantity		Value
	Gross weight	Bromine content		Gross weight	Bromine content	
Ethylene dibromide	279,191	237,508	44,126	316,603	269,334	49,325
Methyl bromide	W	W	W	24,683	20,768	8,381
Other compounds [1]	105,132	75,804	45,926	84,962	58,934	39,770
Total	384,323	313,312	90,052	426,248	349,036	97,476

W Withheld to avoid disclosing individual company confidential data; included with "Other compounds."
[1] Includes ammonium, sodium, potassium, ethyl, and other bromides.

Table 3.—Domestic bromine producers

State	Company	County	Plant	Production source
Arkansas	Arkansas Chemicals, Inc.	Union	El Dorado	Well brines.
	Bromet Co.	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.

seven companies. Two of these plants extracted elemental bromine only for sale and did not produce compounds. In addition, other plants, not shown in table 3, made compounds only from purchased bromine.

CONSUMPTION AND USES

The Bureau of Mines has not surveyed the consumers of bromine and bromine compounds for many years and therefore does not have 1972 data on the final disposition of these products. It was known, however, that over 74% of U.S. production in 1972 went to the manufacture of ethylene dibromide. Most of this production was used in gasoline additives, but the compound was also used in agriculture and as a solvent. In 1971 there was great pessimism over the future of ethylene dibromide because of the Clean Air Act of 1970, which required a 90% reduction in harmful emissions from automobile exhausts by the year 1975. This pessimism, however, was apparently not justified by actual conditions because, in 1972, the industry rebuilt depleted inventories and developed new markets for bromine compounds.

The use of bromine in the manufacture of flame retardants was also believed to be on the increase. It was estimated that between 3% and 4% of total bromine production went into the manufacture of flame retardants in 1972.

Agricultural chemicals also increased, but the extent of the increase was not known. Methyl bromide was classed primarily as an agricultural chemical because of its extended use as a soil sterilant and insect fumigant. Many of the agricultural chemicals were proprietary, and their exact composition was not widely known.

Elemental bromine was utilized as a disinfectant, algaecide, and as an oxidizing intermediate in the manufacture of other chemicals.

PRICES

Prices quoted at yearend for bromine and bromine compounds in Chemical Marketing Reporter were as follows:

	Cents per pound
Bromine, purified:	
Cases, carlots, truckloads, delivered east of Rocky Mountains	49
Zone I: [1]	
Returnable drums, carlots, truckloads, delivered	30
Bulk tank car, tanktrucks (45,000-pound minimum), delivered	17
Ammonium bromide, national formulary (N.F.), granular drums, carlots, truckload, freight equalized	48.5
Bromochloromethane, drums, carlots, freight equalized	54.5
Tanks, same basis	53
Ethyl bromide, technical, 98% drums, carlots, freight allowed, East	68
Ethylene dibromide, drums, carlots, freight equalized	25
Tanks, freight equalized	20
Methyl bromide, distilled, tanks, 140,000-pound minimum, freight allowed	34
Potassium bromate, granular, powdered, 200-pound drums, carlots, freight allowed	64–77
Potassium bromide, N.F., granular, drums, carlots	43.5
Sodium bromide, N.F., granular, 400-pound drums, freight equalized	40

[1] Delivered prices for drums and bulk shipped west of Rockies, 1 cent per pound higher. Bulk tanktruck 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.

The average unit price of bromine made by manufacturers in 1972 was about 5% lower than the 1971 price.

FOREIGN TRADE

Exports of bromine and bromine compounds from the United States were not separately tabulated. Scattered reports in the press indicated that bromine exports increased in 1972, but few quantitative data were given.

There was only slight incentive to import any bromine or bromine compounds into the United States in competition with the vast domestic supply and competitive price situation. The actual import figures for 1972 consisted mostly of potassium bromide from France and the United Kingdom. Its total valuation was under $14,000.

WORLD REVIEW

The United States produced and consumed three-fourths of the world production of bromine in 1972.

Israel.—Israel has an enormous resource of bromine estimated at 1 billion tons, in the brine of the Dead Sea. This is a virtually inexhaustible supply when compared to the 1972 production of 30 million pounds of bromine. About one-third of this bromine was converted into compounds within the country, and over one-half of it was exported as elemental bromine to European countries. Elemental bromine was exported in lead-lined steel tanks that held 3.5 tons of bromine each.

Italy.—The bromine industry of Italy was reported to be producing about 6 million pounds of bromine per year. A bromine plant of Margherita di Savoia Apulia, enlarged its production capacity. This plant extracted bromine from local saltbeds.

Japan.—Japan obtained more than 95% of its bromine from sea water and was reported to have produced about 27 million pounds in 1972. One company, Toyo Soda, produced more than 90% of the bromine in Japan and it recently increased its production capacity by 6.6 million pounds per year. Bromine exports from Japan were small, and total imports, mostly from the United States and from Israel were less than 5% of the Japanese consumption.

TECHNOLOGY

The mechanism by which brominated flame retardants and fire extinguishers operate was explained clearly in a recent article by Walter M. Haessler of Florida

State Fire College.[3] A bromide chemical such as bromotrifluoromethane, CF_3Br, interrupts the flame-combustion chain reaction in a dramatic fashion without removal of fuel or air. Under the heat of the flame, CF_3Br is partially ionized and the resultant bromine ion combines with a hydrogen ion of the flame to form hydrobromic acid. This compound, in turn, reacts with a hydroxyl ion of the flame to form water and leaves a bromine ion ready for recycling through the same series. A single bromide ion may thus remove several of the combustion-chain-carrier ions, namely the hydrogen, H^+, and the hydroxyl, OH^- ions. Other bromine-bearing chemicals react in a similar manner.

[3] Chemical Engineering. Deskbook Issue. V. 80, No. 5, Feb. 26, 1973, pp. 95–100.

Cadmium

By Burton E. Ashley [1]

Strengthening interest in cadmium was presaged by rising producers' prices that increased from $1.50 early in the year, to $3.00 per pound at yearend. Domestic production of cadmium metal, at 8.3 million pounds, gained 5% over the 1971 level, and value of producer shipments increased by 93% to $19 million. Apparent consumption rose 16% to 12.6 million pounds. Seven companies operating eight plants accounted for all domestic output.

Export trade in cadmium increased considerably from the 1971 quantity of 66,000 pounds to slightly over 1 million pounds; imports for the year declined by 31% to 2.4 million pounds.

Legislation and Government Programs.—Sales from the national stockpile amounted to 959,100 pounds; such sales were authorized by Public Law 91–314 of July 10, 1970. At yearend a total of 9,213,358 pounds of cadmium remained in the stockpile, of which 3,213,358 pounds was available for disposal. The stockpile objective remained at 6.0 million pounds.

On January 10, General Services Administration (GSA) announced that 600,000 pounds of cadmium ingot and slab would be available for sale at $1.58 per pound, f.o.b. storage location, in lots of 2,000 pounds or more, and at $1.63 per pound in lots of less than 2,000 pounds. Sticks in lots of more, or less, than 2,000 pounds were priced at $1.70 and $1.75 per pound, respectively. This offering was disposed of by February 1.

On April 3 an additional 600,000 pounds was put on sale; sticks were priced at $2.55 per pound in lots of 2,000 pounds or more and at $2.60 per pound in lots of less than 2,000 pounds. Slabs and ingots brought $2.43 per pound in lots of less than 2,000 pounds. Disposals in the second quarter amounted to 260,100 pounds. On July 6, GSA announced the availability from the stockpile of 600,000 pounds of cadmium in stick form at $2.55 per pound in lots of 2,000 pounds or more and at $2.60 per pound in lots of less than 2,000 pounds. No cadmium was sold at this offering. For the last quarter of the year cadmium sticks from the stockpile were priced at $2.95 and $3.00 per pound in quantities of 2,000 pounds and more and for lots of less than 2,000 pounds, respectively. Disposals amounted to 99,000 pounds, of which 10,000 pounds was bartered.

At midyear the U.S. Department of the Treasury announced that cadmium from Japan had been imported at less than fair value and that an industry had been injured. As a consequence, special dumping duties were to be assessed on the subject merchandise imported at less than fair value after March 24, 1971. Duties were to be assessed on a case-by-case basis and any sales made at fair value would not be subject to dumping duties.

The Office of Minerals Exploration, U.S. Geological Survey, provides up to 50% of allowable costs of exploration for cadmium to eligible participants. Cadmium producers were granted a depletion allowance of 22% on domestic production and 14% on foreign production.

DOMESTIC PRODUCTION

Domestic production of cadmium metal was fairly uniform at slightly more than 2 million pounds for each quarter of the year, except for the third quarter when output was 1.9 million pounds. Total production for 1972, at 8.3 million pounds, gained 5% over the 1971 level. Value of

[1] Physical scientist, Division of Nonferrous Metals.

producer shipments increased over the 1971 total by 93% to $19 million.

Imports of flue dust from Mexico contained 741,000 pounds of cadmium for domestic recovery and refining. Other sources of cadmium for U.S. producers were provided by imports of zinc ore and small amounts of waste and scrap.

The cadmium content of sulfide compounds produced (including cadmium sulfoselenide and lithopone) gained 21% over the 1971 level, to 2.7 million pounds.

Cadmium oxide was produced by American Smelting and Refining Company and Blackwell Zinc Co.

Table 1 shows comparative salient statistics for cadmium for 1968–72; table 2 refers to cadmium sulfide output for the same period.

Table 1.—Salient cadmium statistics

(Thousand pounds)

	1968	1969	1970	1971	1972
United States:					
Production [1]	10,651	12,646	9,465	7,930	8,290
Shipments by producers [2]	11,244	12,978	6,848	7,774	10,480
Value thousands	$28,409	$40,636	$24,163	r $9,823	$18,965
Exports	530	1,085	373	66	1,017
Imports for consumption, metal	1,927	1,078	2,492	3,499	2,422
Apparent consumption	13,328	15,062	9,063	10,873	12,614
Price: Average [3] per pound	$2.65	$3.27	$3.57	$1.92	$2.56
World: Production	33,105	r 38,784	36,454	34,241	36,599

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.

Table 2.—Cadmium sulfide [1] produced in the United States

(Thousand pounds)

Year	Sulfide [2] (cadmium content)
1968	2,457
1969	2,439
1970	2,137
1971	2,235
1972	2,714

[1] Cadmium oxide withheld to avoid disclosing individual company confidential data.

[2] Includes cadmium lithopone and cadmium sulfoselenide.

CONSUMPTION AND USES

Apparent consumption of cadmium (see table 3) amounted to 12.6 million pounds, a 16% gain over apparent consumption in 1971. Government sales increased considerably from 1,000 pounds in 1971 to 959,100 pounds in 1972.

The plating industry probably accounted for not less than one-half of cadmium consumption in the United States. Cadmium plating affords an attractive thin finish and under marine conditions is particularly resistant to corrosion. Its plating uses included parts for vehicles and boats, small household appliances, hardware, and fasteners, such as nuts, bolts, screws, and other accessories.

Cadmium compounds were used as colorants in plastics, paint, and printing ink; they were also used as stabilizing agents in the manufacture of plastics.

Cadmium was also used as a component of sealed and vented batteries. Such batteries were used to power hand tools and communication equipment, and as independent power sources for internal operational needs in vehicles. Cadmium was used as an alloy for hardening copper, in fusible alloys, and in electrical contacts in switches and relays.

Table 3.—Apparent consumption of cadmium

(Thousand pounds)

	1971	1972
Stocks—beginning	4,781	5,272
Production	7,930	8,290
Imports, metal	3,499	2,422
Government sales	1	959
Total (supply)	16,211	16,943
Exports	66	1,017
Stocks—end	r 5,272	3,312
Apparent consumption [1]	r 10,873	12,614

r Revised.
[1] Total supply minus exports and yearend stocks.

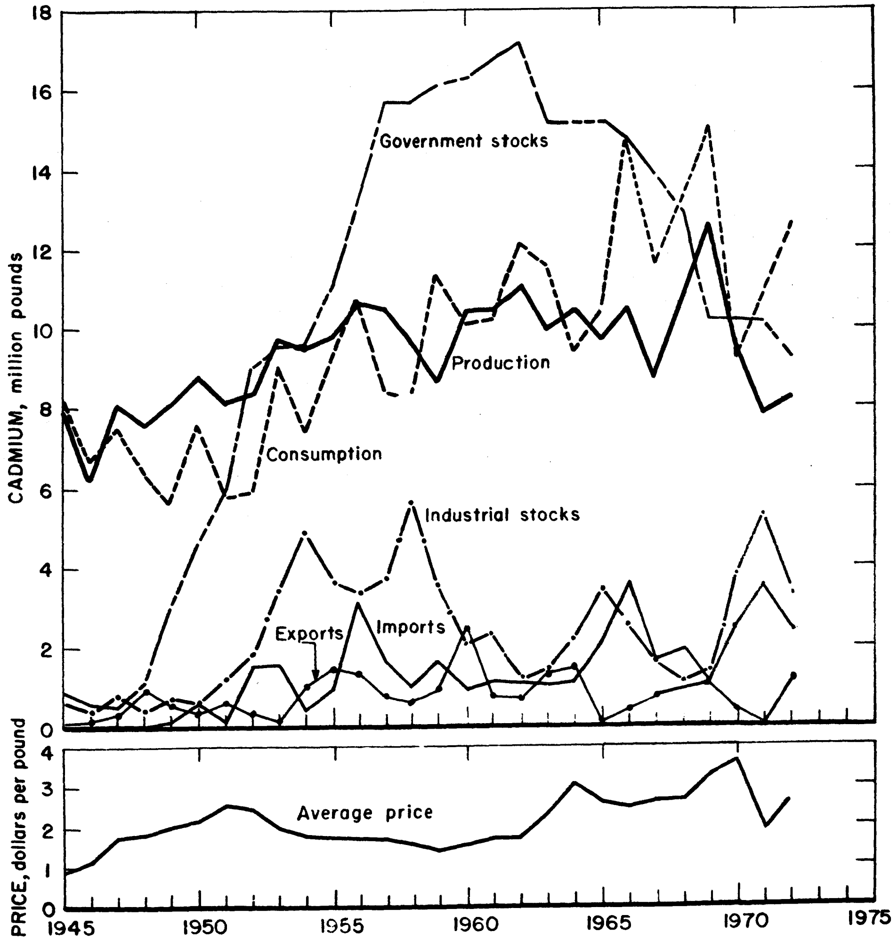

Figure 1.—Trends in production, consumption, yearend stocks, exports, imports, and average price of cadmium metal in the United States.

STOCKS

Yearend 1972 industry stocks of cadmium metal and cadmium content of compounds held in stocks totaled 3.3 million pounds, a decline of 37% from stocks held at yearend 1971. Table 4 lists the details of industry stocks as of December 31, 1971, and December 31, 1972.

Table 4.—Industry stocks, December 31

(Thousand pounds)

	1971		1972	
	Cadmium metal	Cadmium in compounds	Cadmium metal	Cadmium in compounds
Metal producers	3,502	W	1,663	W
Compound manufacturers	492	935	451	932
Distributors	r 303	40	228	38
Total	r 4,297	975	2,342	970

r Revised. W Withheld to avoid disclosing individual company confidential data; included with "Compound manufacturers."

PRICES

The cadmium price of $1.50 per pound in 1-ton lots held for the first 2 days of 1972 when it was raised to $1.75 per pound on January 3. There were three more price rises during the year, as shown in table 5. Price for the year averaged out at $2.56 per pound. Trade sources indicated that toward yearend cadmium was being traded at $2.85 to $2.95 per pound. In December the situation changed because balls were in short supply; it was then reported that sticks were trading at $2.95 per pound and balls had advanced to the premium position of $3.15 per pound.

Table 5.—Cadmium prices 1972

(Dollars per pound)

Date	Producer to consumer	
	1-ton lots	Less than 1-ton lots
Jan. 1	1.50	1.55
Jan. 3 to Jan. 31	1.75	1.80
Feb. 1 to Mar. 8	2.25	2.30
Mar. 9 to Oct. 31	2.60	2.65
Nov. 1 to Dec. 31	3.00	3.05

FOREIGN TRADE

Exports of cadmium metal increased from 66,000 pounds in 1971 to over 1 million pounds in 1972. Chief destinations for 1972 exports were as follows, in percent: Netherlands, 30; Germany, West, 21; France, 21; United Kingdom, 16; and others, 12.

The preponderance of exports to the Netherlands was accounted for by shipments consigned to Rotterdam; most of the cadmium thus shipped was forwarded to other destinations which would not be listed in the U.S. statistics.

Imports of cadmium metal, waste and scrap, totaled 2.4 million pounds, a decline of 31% from the 1971 level; the imports of cadmium-containing flue dust, all from Mexico, also registered a substantial decline of 33%. Canada was the chief source of cadmium metal having furnished 44% of total imports, followed by Australia, 17%; Peru, 12%; and Belgium-Luxembourg, 9%. The remaining 18% came from nine different countries. Value of metal imports declined 22% and that of flue dust 39%.

The duty on imported cadmium metal from countries enjoying most-favored-nation status was discontinued in 1971. Cadmium metal imported from Communist-bloc countries, Yugoslavia excepted, was subject to the statutory duty of 15 cents per pound. Imported cadmium-containing flue dust was duty free.

Table 6 shows U.S. exports of cadmium for 1971 and 1972. U.S. imports of cadmium, by country, are shown in table 7.

Table 6.—U.S. exports of cadmium metal and cadmium in alloys, dross, flue dust, residues, and scrap

(Thousand pounds and thousand dollars)

Year	Quantity	Value
1970	373	997
1971	66	172
1972	1,017	2,363

Table 7.—U.S. imports for consumption[1] of cadmium metal and cadmium flue dust, by country

(Thousand pounds and thousand dollars)

Country	1971		1972	
	Quantity	Value	Quantity	Value
Cadmium metal:				
Argentina	--	--	9	21
Australia	514	950	406	821
Belgium-Luxembourg	457	780	218	467
Canada	375	639	1,068	2,322
Finland	33	55	--	--
France	17	29	17	25
Germany, West	207	328	73	120
Italy	90	161	--	--
Japan	938	1,797	128	177
Mexico	220	312	136	196
Netherlands	81	134	36	64
Peru	332	680	297	600
South Africa, Republic of	67	134	33	70
Spain	22	27	1	3
Switzerland	7	11	--	--
U.S.S.R	--	--	(2)	(2)
United Kingdom	134	220	--	--
Yugoslavia	5	7	--	--
Total	3,499	6,264	2,422	4,886
Flue dust (cadmium content): Mexico	1,112	1,118	741	685
Grand total	4,611	7,382	3,163	5,571

[1] In 1971 general imports were 3,470,323 pounds ($6,208,146); 1972 general imports and imports for consumption were the same.
[2] Less than ½ unit.

WORLD REVIEW

World smelter production of cadmium increased by 7% over the preceding year to a total of 36,599,000 pounds. The United States held its place as the world's largest producer with 23% of the total; Japan followed with 18%; U.S.S.R., 15%; Belgium, 7%; Germany, West, 6%, and Canada, 5%. The remaining 26% was produced by 22 other countries.

Apparent consumption in the United States was equivalent to about 35% of world production. Table 8 shows preliminary figures of world cadmium production in 1972, by country.

Table 8.—Cadmium: World smelter production by country [1]

(Thousand pounds)

Country	1970	1971	1972 p
North America:			
Canada	1,845	1,569	e 1,940
United States [2]	9,465	7,930	8,290
Latin America:			
Mexico	591	423	e 440
Peru	410	377	e 385
Europe:			
Austria	r 47	56	e 55
Belgium	r 2,407	2,088	e 2,500
Bulgaria e	440	440	440
Finland	196	265	e 375
France	r 1,164	1,276	e 1,280
Germany, East e	33	r 33	33
Germany, West	2,282	2,163	e 2,180
Italy	937	772	e 904
Netherlands e	r 245	271	265
Norway	216	203	e 200
Poland	990	1,100	1,200
Romania e	180	180	180
Spain	245	225	e 220
U.S.S.R. e	5,200	5,300	5,400
United Kingdom	701	578	530
Yugoslavia	331	309	e 310
Africa:			
South-West Africa Territory of [3]	511	432	e 420
Zaire	699	575	e 575
Zambia	26	22	e 26
Asia:			
China, People's Republic of e	220	220	220
India	75	64	e 73
Japan	r 5,403	5,898	6,678
Korea, North e	240	240	240
Oceania: Australia	r 1,355	1,232	e 1,240
Total	r 36,454	34,241	36,599

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 flue dusts in a number of other countries, but these materials are exported for treatment elsewhere to recover cadmium metal, therefore output is not recorded in this table to avoid double counting.

[2] Includes secondary.

[3] Output of Tsumeb Corp. Ltd. for year ending June 30 of that stated.

TECHNOLOGY

An instrument was developed by Pye Unicam of Cambridge, England, which could detect 1 part of cadmium (and lead and zinc) in 1 billion parts of liquid in 20 seconds. It can be used to measure levels of the three metals in the bloodstream.[2]

Yuasa Battery Co., Ltd., of Japan reportedly developed an automatic system for removing harmful heavy metal from industrial effluent; the system will reduce cadmium content in effluents to less than 0.1 part per million. A thin synthetic resin membrane is used as the filtration element. Capacity of the various models ranges from 260 to 7,900 gallons per hour.[3]

A simple electrochemical method of preparing cadmium telluride was described; such compounds are useful for windows in infrared lasers, infrared modulators and as nuclear radiation detectors.[4]

U.S. Patent 3,699,207 was granted for a wet metallurgical process for resin extraction of cadmium from flue dusts or zinc liquor cementates.

Environmental Developments.—The Marine Protection Research and Sanctuaries Act of 1972 (P.L. 92-532) was signed into law in October. The law bans the dumping of certain hazardous materials into the ocean and subjects other materials to regulation through a new permit system. The following month 91 nations reached an agreement which regulates controls for the ocean dumping of toxic and dangerous

[2] Mining Journal (London). V. 278, No. 7123, Feb. 25, 1972, p. 159.

[3] News from Ionics. Ionics Inc., Press release, June 1972, 1 p.

[4] Miles, M. H., and W. S. McEwan. Electrochemical Preparation of Cadmium and Mercury Tellurides. J. Electrochem. Soc., v. 119, No. 9, September 1972, pp. 1188–1190.

wastes. As a toxic material, cadmium is one of the metals included in the disposal ban.

The relationship between cadmium pollution and human health received continuing attention. A materials balance was published showing the societal flow of cadmium in the United States for 1968.[5] The flowsheet illustrated the movement of cadmium from mine to environment. Studies have revealed that the daily average human intake of cadmium in the United States is between 0.02 and 0.1 part per million. There was some evidence that a continuous intake of 0.1 part per million may reduce the life span.

Zinc is an essential nutrient for man, but its mineralogical association with cadmium constitutes a hazard to good health. An abstract concerning the relationship of the two metals was published.[6]

The cadmium contamination of soils at a site in British Columbia was evaluated from a standpoint of possible accumulation in man.[7]

H.R. 12958 was introduced to amend the Federal Food, Drug, and Cosmetic Act in February. The Act would regulate the amounts of lead and cadmium which may be released from glazed ceramic or enamel dinnerware. Shortly before H.R. 12958 was introduced it was found that about 100,000 soup bowls had been distributed which contained traces of lead and cadmium. It was thought that the use of the bowls would create no hazard under ordinary circumstances but if they were used to store acid-producing foods, lead and cadmium salts could be released in harmful quantities.

A study of cadmium-related fatal accidents led to determination of quantitative values for cadmium in air. The lethal amount for man of thermally generated cadmium fumes is not over 2,900 minute-milligrams per cubic meter, or an average concentration of 50 milligrams of cadmium per cubic meter of air during a period of 1 hour. Ingestion of 30 milligrams of soluble cadmium salts produced severe toxic symptoms.[8]

Representatives of the Masters Electro-Plating Association (MEPA) in New York presented the city Environmental Protection Administrator with an agreement to remove toxic metals (including cadmium) from waste discharged into surrounding waters. Some 200 electroplating firms were involved. Cost of the collective program was estimated at about $10 million with individual costs reaching as much as $350,000. Equipment will be installed to bring discharges into compliance with the city's sewer regulations.[9]

---

[5] Environmental Quality. Third Annual Report of the Council on Environmental Quality. August 1972, figure 5.

[6] Sanstead, H., M.D. Implications of Zinc-Cadmium Interactions for Health. Abs. With Programs of the 1972 Ann. Meetings of the Geol. Soc. of America, v. 4, No. 7, October 1972, p. 653.

[7] John, M. K., H. H. Chuah, and C. J. Van Laerhoven. Cadmium Contamination of Soil and Its Uptake by Oats. Environmental Sci. and Technol., v. 6, No. 6, June 1972, pp. 555–557.

[8] Reynolds, J. M. Safety Advice—Cadmium. Capital Chemist, May 1972, p. 71.

[9] American Metal Market. V. 79, No. 145, Aug. 7, 1972, p. 4.

Calcium and Calcium Compounds

By Avery H. Reed [1]

Calcium metal was manufactured by one company in Connecticut. Calcium-magnesium chloride was produced by two companies in California and three companies in Michigan. Synthetic calcium-magnesium chloride was manufactured by three companies, in New York, Ohio, 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 1170° C, calcium vaporizes and is collected at one end of the retort.

Leslie Salt Co. and National Chloride Co. of America produced calcium-magnesium chloride from dry lake beds in San Bernardino County, Calif. Output declined 32%.

The Dow Chemical Co., Michigan Chemical Corp., and Wilkinson Chemical Corp. recovered calcium-magnesium chloride from wells in Gratiot, Lapeer, Mason, and Midland Counties, Mich. Output decreased 3%.

Total production of natural calcium-magnesium chloride was 4% less than that of 1971 and was 9% below the 1969 record high.

Allied Chemical Corp., Syracuse, N.Y., PPG Industries, Inc., Barberton, Ohio, and Reichold Chemicals, Inc., Tacoma, Wash., manufactured synthetic calcium-magnesium chloride as a byproduct of soda ash. Total output decreased 2% below the 1968 record.

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.

The principal use for calcium-magnesium chloride was to melt snow and ice from roads, streets, bridges, and pavements. It was also used to keep down dust on roads and driveways and as an accelerator for concrete.

[1] Physical scientist, Division of Nonmetallic Minerals.

Table 1.—Price quotations for calcium chloride
(Per short ton)

Grade	Dec. 27, 1971	Dec. 24, 1972
Flake or pellet, 94–97% [1]	$ 55.00	$ 56.50
Flake, 77–80% [1]	44.00	44.50
Powdered, 77% minimum [1]	52.50	52.50
Liquor, 40% [2]	16.50	17.00
Granulated, U.S.P. [3]	780.00	780.00

[1] Paper bags, carload lots, plant, freight equalized.
[2] Tank cars, freight equalized.
[3] 225-pound drums, freight equalized.

Source: Oil, Paint and Drug Reporter, v. 198, No. 26, Dec. 28, 1971; Chemical Marketing Reporter, v. 202, No. 26, Dec. 25, 1972.

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% $CaCl_2$.

FOREIGN TRADE

Exports of calcium chloride, mainly to Canada, Mexico, the United Kingdom, Venezuela, and Sweden, were 18,750 tons valued at $868,400. Exports of dicalcium phosphate, mainly to Mexico, Canada, Brazil, Taiwan, and Thailand, were 19,710 tons valued at $3,277,000. Exports of precipitated calcium carbonate, mainly to Mexico, Canada, Venezuela, South Vietnam, and Honduras, were 8,940 tons valued at $823,000.

Total imports of calcium and calcium compounds were 137,200 tons valued at $7,291,000. Imports of calcium metal from Ontario were 124 tons valued at $181,400. Imports of calcium chloride, mainly from Canada and Belgium, were 6,128 tons valued at $225,500, a decrease of 53% from those of 1971. Imports of other calcium compounds, mainly from Norway, Turkey, Belgium, France, and Canada, were 131,000 tons valued at $6,884,000.

Imports of other calcium compounds included 46,810 tons of calcium nitrate from Norway, Trinidad, Sweden, and West Germany; 20,780 tons of whiting from France, the United Kingdom, Switzerland, and Belgium; 20,230 tons of calcium borate from Turkey; 19,580 tons of dicalcium phosphate from Belgium, Canada, West Germany, and Japan; 11,110 tons of calcium carbide from Canada; 3,165 tons of calcium cyanamide from Canada, Norway, West Germany, and Belgium; 2,467 tons of calcium cyanide from Canada and Japan; 1,895 tons of precipitated calcium carbonate from United Kingdom, Japan, and West Germany; 999 tons of calcium hypochlorite from Japan; 327 tons of chlorinated lime from the United Kingdom and West Germany; and 3,637 tons of miscellaneous calcium compounds.

Table 2.—U.S. imports for consumption of calcium and calcium chloride

Year	Calcium		Calcium chloride	
	Pounds	Value	Short tons	Value
1968	137,251	$120,416	14,069	$522,680
1969	662,200	619,000	9,226	349,998
1970	164,769	141,125	8,280	359,096
1971	48,391	29,751	13,019	543,656
1972	248,080	181,437	6,128	225,463

Table 3.—U.S. imports for consumption of calcium chloride in 1972, by country

Country	Short tons	Value
Belgium-Luxembourg	964	$44,859
Canada	4,977	169,445
France	21	1,151
Germany, West	1	783
Japan	165	9,225
Total	6,128	225,463

WORLD REVIEW

Canada.—Chromasco Corp. Ltd., produced calcium metal at its Haley, Ontario, smelter. Canada continued to lead all other countries in the production of calcium metal; output in 1971 was 304,000 pounds valued at $282,000. 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.

Carbon Black

By Richard F. Zaffarano [1] and S. O. Wood, Jr.[2]

Carbon black shipments continued their long-term growth pattern in 1972 by increasing 8.0%, following a 6.1% rise in 1971.

Production was a record 3,201 million pounds. Exports continued their decline to a low level of 111 million pounds. A 10.3% gain in domestic sales was one factor that resulted in yearend producer's stocks being 58 million pounds below the 1971 level. The rubber industry continued to be the leading user of carbon black. In 1972, U.S. passenger tire production increased 4% to 195.3 million tires, according to preliminary figures of the Rubber Manufacturers Association, Inc.

The carbon black industry operated at 76.6% capacity in 1972. Daily plant capacity increased 7.2% to a record 11.4 million pounds per day.

Overall production of carbon black in 1972 topped that of the preceding year by 184 million pounds. Channel-black output dropped 24 million pounds.

As shown in table 1, the average value of carbon black at the plant in 1972 was 7.76 cents per pound, an increase of 0.07 cents per pound over that of the previous year.

The volume of natural gas used for manufacturing carbon black declined 9.8 billion cubic feet. Yield also declined from 5.06 pounds per thousand cubic feet in 1971 to 5.02 pounds per thousand cubic feet in 1972. Liquid hydrocarbons feedstocks increased 43 million gallons to a total of 591 million gallons. Average yield increased slightly from 4.92 to 4.96 pounds per gallon.

PRODUCTION AND CAPACITY

Production by State.—Production of carbon black totaled 3,201 million pounds in 1972, an increase of 184 million pounds, 6.1% above the previous year's total. Louisiana supplied 33.7% of the total. Texas' share of the national total was 44.5%. The seven States that produced the remaining 21.8% of carbon black were Alabama, Arkansas, California, Kansas, Ohio, Oklahoma, and West Virginia.

Production by Grade and Type.—Although carbon black was produced by both the channel and furnace processes, the latter accounted for 99.3% of 1972 production. There are seven major grades of carbon black plus thermal black produced by the furnace process. Two of these grades, SRF (Semireinforcing-furnace) and HMF (High-modulus furnace), are gas furnace blacks. The remaining five grades are oil furnace blacks. The HAF (High-abrasion furnace) and ISAF (Intermediate-abrasion furnace) grades continued to lead in the production of oil furnace blacks.

Number and Capacity of Plants.—The total number of producing carbon black plants was 34, three less than in the previous year. In terms of capacity, however, there was an increase from 10.6 million to 11.4 million pounds per day. As shown in table 4, plants in Texas and Louisiana accounted for the major share of the increase in daily capacity.

J. M. Huber Corp. started construction to double its thermal black production capacity to 50 million pounds per year at Borger, Tex.

Materials Used and Yields.—In 1972, a total of 590.8 million gallons of liquid hy-

[1] Physical scientist, Division of Fossil Fuels.
[2] Petroleum engineer, Division of Fossil Fuels.

drocarbons was consumed in the manufacture of 2,930 million pounds of carbon black. This quantity was 43.1 million gallons more than was consumed in 1971. Yields from liquid hydrocarbons in 1972 averaged 4.96 pounds per gallon, compared with 4.92 pounds in 1971. The yield from natural gas dropped to 5.02 pounds from 5.06 pounds per thousand cubic feet. Natural gas feedstock continued to decrease to 53.9 billion cubic feet, and production from natural gas declined to 271 million pounds, 51.5 million pounds below the 1971 level.

CONSUMPTION AND USES

Domestic sales of carbon black increased 10.3% to 3,147 million pounds. Rubber industry consumption increased 10.3% to 2,954 million pounds and accounted for 93.9% of the U.S. total. Sales for use in the manufacture of ink increased 9.7% to 82.5 million pounds. The oil-furnace-type carbon black, known as "Short Ink," was used in manufacturing ink for printing newspapers. Carbon black produced by the channel process, known as "Long Ink," was used in lithographic or halftone printing ink. Consumption of carbon black in paint manufacturing had the greatest increase, 14.5%. The volume of carbon black used in paints increased to 21.4 million pounds. Miscellaneous uses, including chemical, food, and plastics, increased 9.1% to 84.8 million pounds.

STOCKS

Inventory of carbon black at yearend 1972 was 238 million pounds, 19.7% less than comparable yearend stocks in 1971. Largest contributor to the decline was thermal black inventories, which declined from 68 million to 17 million pounds. HAF and SAF were the only grades of furnace blacks that had significantly higher yearend 1972 stocks than at yearend 1971. Respectively, these stocks were 14.6 million and 1.0 million pounds higher. Inventory of channel black at yearend 1972 was 7.7 million pounds, 2.0 million pounds less than yearend 1971 stocks.

FOREIGN TRADE

Carbon black exports totaled 111.3 million pounds, a decrease of 51.9 million pounds from the 1971 total. Value of exports totaled $14.9 million, $5.5 million less than the value of 1971 exports. Furnace black accounted for 89% of exports.

Leading recipients of carbon black produced in the United States were Canada, 19.7 million pounds; Netherlands, 16.0 million pounds; France, 13.8 million pounds; and Japan, 8.0 million pounds. These four countries accounted for approximately one-half of U.S. exports.

Most carbon black imported into the United States was specialty grades. Total imported volume was 7.24 million pounds, of which 6.02 million pounds was acetylene black. Major suppliers of acetylene black to the U.S. were Canada, 5.72 million pounds, and East Germany, 0.25 million pounds. Brazil exported 66,138 pounds of bone black to the U.S. Other major exporters of carbon black to the U.S. included West Germany, 0.58 million pounds, and Indonesia, 0.52 million pounds.

WORLD REVIEW

Carbon black production continued to increase worldwide. Decreased production was not reported for any country. Total world output was estimated to be 7.07 billion pounds. Insufficient data were available to make reliable estimates of output for several countries. (See table 11.) Japan, with an increase of 10.6%, had a high rate of growth. However, the United States, with an increase in output of 184 million pounds, had the largest volume increase.

Worldwide, several new operations and expansions were under construction or in the engineering stage to increase output of carbon black. Among the projects were the following: Cancarb Ltd. was in the engineering stage for a 480-ton-per-day thermal carbon black plant at Medicine Hat, Alberta, Canada. Gofi-Nasr Petroleum Co. had a 10,000-ton-per-year plant at Alexandria, Egypt, in the engineering stage. United Carbon India Ltd. expanded capacity of its Bombay, India, plant by 4,900 tons per year. Phillips Carbon Black Italiana S.p.A. increased capacity at its Milan, Italy, plant from 92.6 million to 114.7 million pounds per year. Continental-Columbian Carbon Nederland NV., subsidiary of Continental Carbon and Columbia Carbon Co., was increasing capacity of its Botlek-Rotterdam plant by 15,000 tons per year. Also, Phillips Carbon Black Co. Pty. Ltd. was expanding its Port Elizabeth, Republic of South Africa, plant from 56.7 million to 83.8 million pounds per year. Ashland Oil Canada Ltd. was constructing in Levis County, Quebec, a 40-million-pound-per-year carbon black plant. The French subsidiary of a U.S. joint venture of Phillips Petroleum Co. and Continental Carbon Co. was expanding its Bordeaux carbon black plant from 97 to 129 million pounds per year.

In Canada, Cantex Associates started construction of a 40-million-pound-per-year specialty carbon black plant in Medicine Hat, Alberta. The specialty thermal black, currently produced only in the southern United States, is used in rubber products with a growth market in a new generation of products now being manufactured. This new plant is expected to meet total Canadian demand, estimated to be about 20 million pounds in 1974 and serve export markets in the U.S. and Pacific countries. Presently all Canadian needs for specialty black are imported.

TECHNOLOGY

Carbon black, a petrochemical, is an extremely fine soot, primarily carbon (90 to 99%), that contains some oxygen and hydrogen. Oil furnace black may contain also small amounts of sulfur. The properties of carbon black are determined largely by the process by which it is manufactured. Furnace black, which accounts for 99% of all carbon black produced, is made by three different processes—oil furnace, gas furnace, and thermal. Brief descriptions of these processes, of the channel process, and of the manufacture of lampblack and acetylene black follow.

Oil Furnace.—In the oil furnace process, liquid hydrocarbons are used. 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 GPF, FEF, HAF, ISAF, and SAF. (The full name of each grade is given in the footnotes to table 3.)

The most desirable feedstock oil for furnace black plants has zero to 4° API gravity and is low in sulfur and 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. The rising cost of natural gas has been a factor in the shift to greater use of liquid feedstocks and a decline in the use of natural gas as a source of carbon. At the same time, it should be recognized that oil furnace processing has become very flexible. Oil furnace blacks supplement channel blacks in most high-performance applications, notably passenger car tire treads. Over the past 2 decades, carbon black technology has centered on the oil furnace black process.

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 the 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. The grades SRF and HMF are generally produced from gas. (The full name of each grade is given in the footnotes to table 3.)

Thermal.—Unlike channel and furnace blacks, thermal blacks are produced by cracking a hydrocarbon; that is, by separating the carbon from the hydrogen and not by the combustion of a hydrocarbon. Thermal furnaces are built in a checker-board brickwork pattern. Two refractory-lined furnaces, or generators, are used. One generator is heating, using hydrogen as a fuel, while the other generator is being charged with natural gas, which decomposes to produce thermal black and hydrogen. The hydrogen is collected and used as fuel for the generator being heated. Yields of carbon black are primarily in the large particle sizes and range from 40 to 50%.

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. The 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.

Lampblacks.—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 lower in jetness and coloring power. They are of value as tinting pigments in certain paints and lacquers. In most applications they have been replaced by carbon blacks.

Acetylene Black.—Acetylene blacks, produced by the thermal decomposition of acetylene, possess a high degree of structural, or chaining, tendency. Their particle size is about 40 micrometers. They provide high elastic modulus and high conductivity in rubber stocks.

A process for the manufacture of carbon black using highly volatile, vitrain-rich, low-ash coals of Assam has been developed at the Regional Research Laboratory, Jorhot, Assam, for the National Research Development Corp. of New Delhi, India. In the process, handpicked coal is crushed, finely ground, and flash decomposed. The product is subsequently treated in a fluidized-bed refractory reactor at a fixed temperature, with air as the fluidizing medium. After initial separation of the char in a cyclone separator, the carbon black can be recovered from the flue gases by water scrubbing and electrostatic precipitation. The carbon black is then pelletized and dried at a temperature of 300°–400° C. The yield is approximately 20%.

Table 1.—Salient statistics of carbon black produced from natural gas and liquid hydrocarbons in the United States

(Thousand pounds)

	1968	1969	1970	1971	1972
Production:					
Channel process	142,948	132,471	113,548	46,354	22,378
Furnace process	2,668,858	2,830,790	2,817,605	2,970,781	3,178,731
Total	2,811,806	2,963,261	2,931,153	3,017,135	3,201,109
Shipments (including losses):					
Domestic	2,588,761	2,783,208	2,650,450	2,853,948	3,148,114
Exports	263,122	196,203	192,636	163,246	111,328
Total	2,851,883	2,979,411	2,843,086	3,017,194	3,259,442
Producer stocks Dec. 31	224,170	208,020	296,087	296,028	237,695
Value:					
Production______thousand dollars	205,849	215,120	222,271	232,049	248,361
Average per pound_________cents	7.32	7.26	7.58	7.69	7.76

Table 2.—Carbon black produced from natural gas and liquid hydrocarbons in the United States, by State

(Thousand pounds)

	1968	1969	1970	1971	1972	Change from 1971 (%)
Louisiana	1,031,349	1,045,902	982,416	1,078,732	1,077,977	−0.1
Texas	1,426,307	1,442,033	1,395,851	1,326,153	1,425,874	+7.5
Other States	354,150	475,326	552,886	612,250	697,258	+13.9
Total	2,811,806	2,963,261	2,931,153	3,017,135	3,201,109	+6.1

Table 3.—Production and shipments of carbon black in the United States in 1972, by month and grade

(Thousand pounds)

	SRF [1]	GPF [2]	FEF [3]	HAF [4]	SAF [5]	ISAF [6]	Thermal	Total (furnace)	Channel	Total
PRODUCTION [7]										
January	20,993	47,319	28,980	72,116	3,788	49,047	21,321	243,564	2,603	246,167
February	21,834	43,165	27,849	78,345	2,740	46,179	20,303	240,415	2,394	242,809
March	22,261	57,418	34,109	95,627	3,205	41,854	23,287	277,761	2,527	280,288
April	22,135	51,903	31,749	91,593	3,085	44,550	20,975	265,990	2,158	268,148
May	23,478	55,777	33,651	100,116	927	41,597	21,214	276,760	2,298	279,058
June	22,649	50,332	33,163	87,270	4,299	36,946	18,341	253,000	1,663	254,663
July	23,022	56,625	28,322	92,341	2,643	29,455	19,279	251,687	1,370	253,057
August	22,699	51,821	29,382	100,659	3,855	29,554	20,867	258,837	1,644	260,481
September	21,748	51,146	31,727	102,126	2,986	31,930	20,164	261,827	1,743	263,570
October	25,534	57,221	35,211	108,329	4,921	32,446	21,260	284,922	1,629	286,551
November	26,846	59,758	33,010	106,459	6,522	30,163	19,560	282,318	1,134	283,452
December	22,413	55,973	35,586	109,977	2,763	32,641	22,297	281,650	1,215	282,865
Total	275,612	638,458	382,739	1,144,958	41,734	446,362	248,868	3,178,731	22,378	3,201,109
SHIPMENTS (including exports) [8]										
January	22,535	52,277	31,804	78,733	3,658	48,551	24,340	261,898	3,939	265,837
February	23,116	49,813	30,977	81,638	2,452	48,005	23,168	259,169	2,669	261,838
March	26,818	58,594	33,131	91,713	4,452	47,337	23,714	285,759	2,008	287,767
April	22,131	48,231	30,297	81,089	2,303	40,956	24,020	249,027	2,030	251,057
May	25,719	57,276	32,922	102,467	1,940	42,744	26,605	289,673	2,139	291,812
June	23,012	51,182	31,737	89,407	3,444	35,984	22,944	257,710	2,019	259,729
July	20,212	48,154	25,727	85,553	2,496	28,058	21,914	232,114	1,193	233,307
August	23,335	52,867	31,179	96,703	3,673	30,360	25,791	263,908	1,692	265,600
September	22,905	53,466	33,938	102,186	3,383	34,433	26,050	276,361	1,779	278,140
October	26,341	59,339	33,719	111,339	4,517	33,199	31,240	299,694	1,520	301,214
November	27,211	58,190	37,349	111,993	5,361	31,625	25,606	297,335	1,810	299,145
December	21,519	54,761	29,761	97,489	3,035	31,422	24,363	262,350	1,646	263,996
Total	284,854	644,150	382,541	1,130,310	40,714	452,674	299,755	3,234,998	24,444	3,259,442

[1] Semireinforcing furnace.
[2] General purpose furnace (includes High-modulus furnace).
[3] Fast-extrusion furnace.
[4] High-abrasion furnace.
[5] Superabrasion furnace.
[6] Intermediate-abrasion furnace.
[7] Compiled from reports of a survey firm and producing companies. Figures adjusted to agree with annual reports of individual producers.
[8] Includes losses.

Table 4.—Number and capacity of carbon black plants operated in the United States

State	County or Parish	Number of plants 1971 Channel	Number of plants 1971 Furnace	Number of plants 1972 Channel	Number of plants 1972 Furnace	Total daily capacity (pounds) 1971	Total daily capacity (pounds) 1972
Texas	Aransas	--	1	--	1	4,697,737	5,075,602
	Carson	1	--	1	--		
	Ector	1	--	--	--		
	Gaines	1	--	1	--		
	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		3	12	2	12	4,697,737	5,075,602
Louisiana	Avoyelles	--	1	--	1	r 3,575,374	3,870,108
	Calcasieu	--	1	--	1		
	Evangeline	--	1	--	1		
	Ouachita	--	2	--	2		
	St. Mary	--	3	--	3		
	West Baton Rouge	--	1	--	1		
Total Louisiana		--	9	--	9	r 3,575,374	3,870,108

See footnote at end of table.

Table 4.—Number and capacity of carbon black plants operated in the United States—Continued

State	County or Parish	Number of plants 1971 Channel	Number of plants 1971 Furnace	Number of plants 1972 Channel	Number of plants 1972 Furnace	Total daily capacity (pounds) 1971	Total daily capacity (pounds) 1972
Alabama	Russell	--	1	--	1	2,374,219	2,465,849
Arkansas	Union	--	1	--	1		
California	Contra Costa	--	1	--	--		
	Kern	--	2	--	3		
	Mojave (District)	--	1	--	--		
Kansas	Grant	--	1	--	1		
New Mexico	Lea	--	1	--	--		
Ohio	Lucas	--	1	--	1		
	Washington	--	1	--	1		
Oklahoma	Kay	--	1	--	1		
West Virginia	Pleasants	--	1	--	1		
	Marshall	--	1	--	1		
Total other States		--	13	--	11	2,374,219	2,465,849
Total United States		3	34	2	32	r 10,647,330	11,411,559

r Revised.

Table 5.—Carbon black and the feedstocks used in its production, by State

	Louisiana	Texas	Other States [1]	Total
1971				
Carbon black production:				
Total thousand pounds	1,078,732	1,326,153	612,250	3,017,135
Value thousand dollars	78,169	108,679	45,201	232,049
Average value cents per pound	7.25	8.19	7.38	7.69
Natural gas used:[2]				
Total million cubic feet	25,984	31,987	5,728	63,699
Value thousand dollars	4,552	5,551	1,051	11,154
Average value cents per thousand cubic feet	17.52	17.35	18.35	17.51
Carbon black produced [3] thousand pounds	257,759	42,855	21,817	322,431
Liquid hydrocarbons used:				
Total thousand gallons	170,864	263,976	112,864	547,704
Value thousand dollars	12,989	21,139	9,469	43,597
Average value cents per gallon	7.60	8.01	8.39	7.96
Carbon black produced thousand pounds	820,973	1,283,298	590,433	2,694,704
1972				
Carbon black production:				
Total thousand pounds	1,077,977	1,425,874	697,258	3,201,109
Value thousand dollars	78,843	117,963	51,555	248,361
Average value cents per pound	7.31	8.27	7.39	7.76
Natural gas used:[2]				
Total million cubic feet	23,563	24,720	5,656	53,939
Value thousand dollars	4,721	4,356	1,460	10,537
Average value cents per thousand cubic feet	20.04	17.62	25.81	19.54
Carbon black produced [3] thousand pounds	207,575	43,219	20,182	270,976
Liquid hydrocarbons used:				
Total thousand gallons	177,633	277,642	135,478	590,753
Value thousand dollars	14,051	22,572	11,405	48,028
Average value cents per gallon	7.91	8.13	8.41	8.13
Carbon black produced thousand pounds	870,402	1,382,655	677,076	2,930,133

[1] Arkansas, California, Kansas, Ohio, Oklahoma, and West Virginia.
[2] Includes natural gas used to enrich liquid hydrocarbons.
[3] Produced from natural gas used as feedstock.

Table 6.—Natural gas and liquid hydrocarbons used in manufacturing carbon black in the United States and average yield

	1968	1969	1970	1971	1972
Natural gas used [1] million cubic feet	104,973	98,251	85,884	63,699	53,939
Average yield of carbon black per thousand cubic feet pounds	4.34	4.64	4.44	5.06	5.02
Average value of natural gas used per thousand cubic feet cents	13.71	14.88	16.45	17.51	19.54
Liquid hydrocarbons used thousand gallons	484,404	524,370	523,914	547,704	590,753
Average yield of carbon black per gallon pounds	4.86	4.78	4.87	4.92	4.96
Average value of liquid hydrocarbons used per gallon cents	7.11	7.23	7.35	7.96	8.13
Number of producers reporting	8	9	9	9	8
Number of plants	35	38	37	37	34

[1] Includes natural gas used to enrich liquid hydrocarbons.

Tble 7.—Sales of carbon black for domestic consumption in the United States, by use

(Thousand pounds)

Use	1968	1969	1970	1971	1972	Change from 1971 (%)
Ink	67,721	73,077	72,824	75,201	82,532	+9.74
Paint	13,435	17,711	14,570	18,693	21,408	+14.52
Paper	4,710	5,668	4,527	3,767	4,225	+12.15
Plastics	26,863	(1)	(1)	(1)	(1)	--
Rubber	2,445,550	2,616,166	2,486,146	2,678,151	2,953,779	+10.29
Miscellaneous [2]	30,123	65,327	71,454	77,715	84,764	+9.07
Total	2,588,402	2,777,949	2,649,521	2,853,527	3,146,708	+10.27

[1] Included in "Miscellaneous."
[2] Chemical, food, and plastics (1969–1972) combined with "Miscellaneous" to avoid disclosing individual company confidential data.

Table 8.—Producers' stocks of channel-and furnace-type blacks in the United States, December 31

(Thousand pounds)

Year	Furnace									Channel	Total
	SRF [1]	HMF [1]	GPF [1]	FEF [1]	HAF [1]	SAF [1]	ISAF [1]	Thermal	Total		
1968	29,695	2,900	14,756	20,047	55,590	3,592	41,621	23,074	191,275	32,895	224,170
1969	24,478	2,518	20,082	22,254	48,725	4,734	38,712	28,044	189,547	18,473	208,020
1970	37,875	2,048	46,930	24,771	64,106	5,666	50,513	42,119	274,028	22,059	296,087
1971	33,551	3,158	35,885	27,619	68,798	6,417	42,870	67,987	286,285	9,743	296,028
1972	24,309	(2)	33,351	27,817	83,446	7,437	36,558	17,100	230,018	7,677	237,695

[1] For explanation, see footnotes to table 3.
[2] Included with GPF.

Table 9.—U.S. exports of carbon black, by country

(Thousand pounds and thousand dollars)

Country	1970		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value
North America:						
Canada	21,917	2,195	26,736	2,472	19,735	2,057
Guatemala	1,186	113	396	42	148	17
Mexico	2,742	302	2,080	247	1,662	273
Other	1,766	178	1,295	121	538	52
Total	27,611	2,788	30,507	2,882	22,083	2,399
South America:						
Argentina	1,793	304	3,412	433	1,425	248
Brazil	5,343	565	6,423	689	3,553	385
Chile	357	58	433	69	318	54
Colombia	515	104	529	97	471	77
Peru	231	25	192	27	250	29
Venezuela	695	88	941	100	809	97
Other	202	24	183	24	55	9
Total	9,136	1,168	12,113	1,439	6,881	899
Europe:						
Austria	159	31	81	21	140	43
Belgium-Luxembourg	4,559	409	2,143	233	2,931	278
Denmark	1,355	273	823	130	954	180
Finland	412	69	163	27	302	33
France	35,603	3,751	16,514	1,900	13,815	1,558
Germany, West	15,338	1,766	6,997	878	7,252	792
Italy	12,055	1,657	5,894	830	4,212	552
Netherlands	13,484	2,047	43,622	5,550	15,998	2,503
Norway	1,052	84	874	82	433	42
Portugal	509	66	253	39	278	43
Spain	4,457	587	2,295	274	1,961	261
Sweden	3,392	338	1,006	89	192	24
Switzerland	1,271	145	986	93	955	103
United Kingdom	16,638	3,032	6,416	989	5,525	903
Yugoslavia	147	38	99	26	148	42
Other	172	45	168	25	71	14
Total	110,603	14,338	88,334	11,186	55,167	7,371

Table 9.—U.S. exports of carbon black, by country—Continued

(Thousand pounds and thousand dollars)

Country	1970		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value
Africa:						
Ghana	1,122	100	1,089	100	940	115
Kenya	--	--	631	56	748	67
South Africa, Republic of	6,696	646	5,939	600	4,431	424
Tanzania	--	--	168	16	51	6
Other	427	94	125	15	56	8
Total	8,245	840	7,952	787	6,226	620
Asia:						
India	1,468	207	912	146	1,988	233
Indonesia	432	38	185	15	195	16
Iran	1,457	132	573	50	91	15
Israel	383	42	324	38	468	51
Japan	9,905	2,596	8,828	2,335	7,996	2,117
Korea, Republic of	3,481	354	480	95	532	120
Pakistan	3,159	292	209	18	226	18
Philippines	689	69	637	72	625	59
South Vietnam	1,368	144	725	88	1,071	93
Taiwan	583	109	796	196	748	159
Thailand	1,406	124	1,050	92	634	58
Turkey	1,798	160	687	66	100	14
Other	1,256	131	760	98	994	109
Total	27,385	4,398	16,166	3,309	15,668	3,062
Oceania:						
Australia	6,951	728	6,074	635	3,523	407
New Zealand	2,705	245	2,100	187	1,780	166
Total	9,656	973	8,174	822	5,303	573
Grand total	192,636	24,505	163,246	20,425	111,328	14,924

Table 10.—U.S. exports of carbon black in 1972, by month

(Thousand pounds and thousand dollars)

Month	Channel		Furnace		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
January	1,561	515	8,914	869	10,475	1,384
February	1,489	598	9,262	880	10,751	1,478
March	541	306	6,109	639	6,650	945
April	944	393	5,827	550	6,771	943
May	1,309	532	9,889	905	11,198	1,437
June	853	302	7,997	789	8,850	1,091
July	857	407	8,414	775	9,271	1,182
August	504	328	6,434	594	6,938	922
September	1,055	449	11,429	1,041	12,484	1,490
October	993	649	9,912	882	10,905	1,531
November	675	255	7,802	635	8,477	890
December	1,253	835	7,305	796	8,558	1,631
Total	12,034	5,569	99,294	9,355	111,328	14,924

Table 11.—Carbon black: World production by country

(Million pounds)

Country [1]	1970	1971	1972 [p]
Argentina [e]	66	66	66
Australia [e]	100	116	128
Belgium	4	[e] 4	[e] 4
Brazil	[r] 108	126	[e] 132
Canada [e]	170	186	196
Colombia [e]	35	40	45
Czechoslovakia [e]	4	22	33
France	328	345	350
Germany, West	523	578	582
Hungary	9	[e] 9	[e] 9
India	[e] 66	84	[e] 88
Indonesia	--	1	[e] 3
Italy	272	276	[e] 278
Japan	650	679	751
Korea, Republic of	7	16	19
Mexico [e]	60	70	74
Netherlands	190	204	206
Romania	160	164	[e] 165
South Africa, Republic of [e]	58	62	66
Spain	[r] 89	[e] 90	[e] 90
Sweden [e]	40	45	50
Taiwan	(2)	(2)	(2)
United Kingdom	464	480	[e] 485
United States	2,931	3,017	3,201
Venezuela	16	[e] 16	[e] 16
Yugoslavia	30	35	[e] 35
Total	[r] 6,380	6,731	7,072

[e] Estimate. [p] Preliminary. [r] Revised.

[1] In addition to the countries listed, the People's Republic of China, Norway, Poland, and the U.S.S.R. produce carbon black, but available information is inadequate to make reliable estimates of output levels.

[2] Less than 1 million pounds.

Cement

By Brinton C. Brown [1]

Portland cement shipments from plants in the United States and Puerto Rico reached another alltime high of 81,432,000 tons in 1972, surpassing the 1971 record by 3%. Mill value rose to $1.65 billion, an increase of 12%, reflecting a unit increase of $1.57 a ton. A record 4.9 million tons of cement and clinker were imported for consumption in the United States and Puerto Rico, an increase of 59%. Cement sales were again spurred by an unprecedented high level of housing construction, particularly in the South. In Florida, for example, building permits increased 55%.

The cement situation in 1972 was a dichotomy of regional shortages and surpluses, with transportation costs a barrier to the solution of both problems. Imports doubled in Florida to alleviate an acute shortage, while domestic producers allocated shipments to customers in that area.

Although production capacity remained unchanged, consumption was rising, costs were escalating upward, and prices increased 8% despite constraints imposed under Phase II of the Economic Stabilization Act. Nevertheless, price increases did not offset rising costs of labor, fuel, power, transportation, and materials. Manufacturers complained that profits were inadequate to provide capital for reinvestment and new plant investment. With the improved demand for cement some companies ameliorated their profit position by operating plants at or near capacity. The real improvement was from the increased volume of cement shipped. Hurricane Agnes in June and exceptionally bad weather in the fourth quarter curtailed cement shipments and prevented sales from reaching an even greater record high.

Curtailed cement production stemming from a natural gas shortage impelled 16 companies to install alternate standby fuel systems. Several companies were investing in natural gas supplies. Kaiser Cement & Gypsum Co. purchased two gas wells and

[1] Mining engineer, Division of Nonmetallic Minerals—Mineral Supply.

Table 1.—Salient cement statistics

(Thousand short tons and thousand dollars)

	1968	1969	1970	1971	1972
United States:					
Production [1] [2]	75,830	76,693	74,325	78,324	82,597
Shipments from mills [1] [2] [3]	76,302	78,637	74,607	80,396	83,336
Value [1] [2] [3] [4]	$1,294,533	$1,354,033	$1,336,255	$1,528,056	$1,724,140
Average value per ton [1] [2]	$16.97	$17.22	$17.91	$19.01	$20.69
Stocks Dec. 31 at mills: [1] [5]	7,892	7,129	7,574	6,381	7,072
Exports	177	111	159	110	101
Imports for consumption	1,370	1,821	2,597	3,088	4,911
Consumption, apparent [6] [7]	77,495	80,348	75,970	81,488	84,994
World: Production	568,065	598,825	629,645	667,614	702,666

[1] Excludes Puerto Rico.
[2] Includes portland, masonry, and slag cement (1968–1969). Excludes slag cement (1970–1972).
[3] Includes imported cement shipped by domestic producers only.
[4] Value received, f.o.b. mill, excluding cost of containers.
[5] Includes portland, masonry (1970–1972), slag cement (1968–1969).
[6] Quantity shipped plus imports minus exports.
[7] Adjusted to eliminate duplication of imports (clinker and cement) shipped by domestic cement manufacturers.

may acquire additional gas wells for its Longhorn plant in Texas. Lone Star Industries, Inc. was undertaking a natural gas exploration and development program in New Mexico and Texas to assure gas supplies for manufacturing cement. Because of the shortage of low-sulfur coal more companies changed from coal to fuel oil. Nevertheless, an impending fuel oil shortage had many companies investigating the use of low-sulfur coal from western States for standby fuel. The cost of all fuels was increasing.

Several plants completed air pollution control projects during the year to comply with present standards and regulations. Most of the plants in the country were modernizing and improving the efficiency of dust-collecting facilities. Many companies were financing pollution control facilities through tax-exempt bonds and securities issued by municipalities and local government agencies. Companies will repay under a lease arrangement with the local governments. These bond issues represented an effective means to raise capital at relatively low cost for essential, but nonproductive, equipment.

In 1972 four new kilns started operation with a combined annual capacity of 1.5 million tons. But by yearend 13 old kilns were permanently removed from service, so the production capacity of the industry remained virtually unchanged. Several new plants and many plant expansion and modernization programs were in various stages of planning and construction.

In response to the Portland Cement Association's (PCA) request for an industrywide price relief the Price Commission held a public hearing in Houston, Tex. on October 6. The Commission received information regarding price controls and related problems of industry capacity, supply shortages, costs, profitability, and capital investment in the cement industry. No decision had been made by yearend.

The year 1972 marked the first full one of experience with a newly developed system of reporting injuries and illnesses under the Williams-Steiger Occupational Safety and Health Act of 1970. The Ideal Cement Co. plant at Portland, Colo., was the leader in the PCA safety honor awards for 1972, working 3,400 consecutive days without a lost-time or disabling injury. Universal Atlas Cement Div. of United States Steel Corp. plants at Leeds, Ala., and Waco, Tex., also completed more than 3,000 accident-free days. Members of the PCA competition with more than 2,000 consecutive days without injuries were: Hawaiian Cement Corp. at Ewa Beach, Oahu; Louisville Cement Co. at Logansport, Ind.; Lone Star Industries at Demopolis, Ala.; and Universal Atlas Cement at Hannibal, Mo. The Manitowoc, Wisc., plant of Medusa Cement Co. received the PCA Twenty-fifth Safety Trophy Reaward for 26 accident-free years (not consecutive). Lone Star Industries plants at Birmingham, Ala., and New Orleans, La., received the PCA Twenty-first Safety Trophy Reaward for 22 years without lost-time injuries.

Legislation and Government Programs.—Two Federal laws were enacted that directly affect environmental aspects of the cement industry. Public Law 92–500, the Federal Water Pollution Control Act Amendments of 1972, effective October 18, extends Federal responsibility from interstate waters to all U.S. waters; calls for States to retain primary responsibility but provides for Environmental Protection Agency (EPA) intervention if States fail to act; requires more stringent effluent limits; requires the EPA to establish guidelines and water quality standards; provides for a permit program to replace the 1899 Refuse Act permit program; provides for penalties up to $50,000 a day and 2 years in prison for second offenses; and specifies dozens of other key provisions. The $24.5 billion authorizations contained in the 98-page act represent the largest single public works program authorization since the enactment of the Federal Interstate Highway Program. Pollutant permit activity administered by the Corps of Engineers under the 1899 Refuse Act was superseded, but the Corps' authority to issue dredge and fill permits was continued.

Public Law 92–574, Environmental Noise Control Act of 1972, effective October 27, directs the EPA to set and enforce noise standards for certain equipment. Provisions of the Occupational Safety and Health Act were designed to eliminate the possibility of hearing loss in three ways: (1) by taking the initial step and making a sound survey; (2) engineering noise out; and (3) using protective devices to reduce noise levels. The Occupational Safety and

Health Administration (OSHA) conducted tests that prove noise levels exceeding 90 decibels (dba) are potentially harmful. Some environmentalists were exerting pressure on the EPA to set 85 dba as the acceptable limit rather than 90 dba. In the cement industry, raw and finish-grinding mills produce 102–105 dba and diesel trucks in quarry operations register 94 dba.

The PCA in a suit against the EPA charged that the new standards established for cement plants under provisions of the Clean Air Act were promulgated without the Administrator's compliance with the National Environmental Policy Act of 1969. Furthermore, the PCA challenged the Administrator on grounds that economic costs were not adequately taken into account and that the standards unfairly discriminate against portland cement plants, in comparison with standards promulgated for powerplants and municipal incinerators. The PCA charged that the achievability of the standards was not adequately demonstrated. The United States Court of Appeals for the District of Columbia Circuit had not given an opinion by yearend. However, the EPA published in the August 25 Federal Register a notice of proposed rule making issued under the authority of the Clean Air Act. Part 60, title 40, Code of Federal Regulations was proposed to be amended by adding a new section, 60.11, dealing with assertedly excusable violations regarding emissions during startup, shutdown, and malfunction of kilns.

Under new Treasury Department regulations a company mixing ammonium nitrate fertilizer with fuel oil as needed to blast limestone in a quarry is considered an explosives manufacturer and a Federal license is required. The regulations, part 181 of title 26 of the Code of Federal Regulations define a manufacturer-limited as any person engaged in the business of manufacturing explosive materials for his own use and not for sale or distribution. A manufacturer-limited license costs $5 and a separate fee is required for each business location.

The Federal Trade Commission (FTC) docket No. C-2375 alleges that the St. Lawrence Cement Co. acquisition of Wyandotte Cement Inc. violates section 7 of the Clayton Act, particularly in view of the Holderbank Financiere Glaris S.A. financial interest in St. Lawrence Cement Co. and Dundee Cement Co., both marketing in the same area. St. Lawrence Cement Co. agreed to sell its assets in Wyandotte, Mich., effective December 31, 1973.

In a February decision, the U.S. Court of Appeals for the Tenth Circuit upheld the FTC order (docket No. 8802) that OKC Corp. divest its interest in Jahncke Service, Inc., a producer of ready-mix concrete. Missouri Portland Cement Co., in a prolonged controversy with the FTC (docket No. 8783), entered into a consent agreement that calls for divestiture of Botsford Ready Mix Co. Lehigh Portland Cement Co. entered into a consent agreement with the FTC in June disposing of the company's holdings in ready-mix concrete companies in Florida, Kentucky, and Virginia. The Kentucky and Virginia subsidiaries were sold. By mid-1974 the company must decide whether to sell the Miami cement plant and keep all 11 ready-mixed concrete plants, or keep the cement plant and sell six ready-mix plants.

Environmental Activities.—During the 10-year period through 1971, approximately $216 million was spent by the cement industry in the United States on capital equipment for air and water pollution control. The EPA estimates that capital expenditures during the period 1972 through 1976 required to bring existing plants into full compliance with present standards and regulations will be $97 million for air pollution abatement and $25 million for water pollution control. Additional millions of dollars will be expended for pollution control facilities installed at new plants and plant expansions under construction. Pollution control facilities comprise 10% to 15% of the capital cost of a new plant, or $5.00 to $6.50 a ton of annual production capacity. The EPA estimates the annual costs of operating pollution control facilities in the cement industry will increase from $3 million in 1972 to $43 million in 1976. This will average about 42 to 53 cents a ton of cement produced. Members of the industry estimate the upper figure to exceed $1.00 a ton.

Many companies petitioned local pollution control agencies to operate plants under variances from the standards and regulations until pollution control facilities could be engineered and installed. To mention a few, Ideal Cement Co. received variances for the following plants: San Juan Bautista, Calif., from the San Benito County Air Pollution Hearing Board; Ada, Okla., from the Oklahoma Air Pollution Control Division; Portland, Colo.; Devils Slide, Utah; and Trident, Mont. The Illinois Pollution Control Board granted a variance to Marquette Cement Manufacturing Co. for its Oglesby, Ill., plant. The Arizona Air Pollution Control Hearing Board granted a 1-year extension to Arizona Portland Cement Co. to operate its Rillito, Ariz., plant under a variance. The Minnesota Pollution Control Agency extended its deadline to July 1974 for Universal Atlas Cement Division of United States Steel Corp. to meet State standards.

Some companies failing to meet standards were cited. The South Carolina Pollution Control Authority issued orders against Santee Portland Cement Co. and Giant Portland Cement Co., located near Holly Hill, S.C. which require the firms to meet all State air quality standards by March 30, 1974. The Michigan Air Pollution Control Commission issued an order to the Huron Cement Div. of National Gypsum Co. setting forth a compliance schedule for elimination of dust emissions from kilns at the company's Alpena, Mich., plant. The order was complied with on four kilns, but the company determined that it was not economical to install collectors for the remaining 12 kilns where dust elimination was required.

Other companies were defendants in legal actions. In a Consent Judgment settling legal proceedings instituted against the American Cement Corp. at its Detroit, Mich. plant by the City of Detroit and Wayne County, the company spent $350,000 on pollution control facilities. Completion of air pollution abatement projects at the General Portland Inc. plant in Chattanooga, Tenn., not only alleviated legal pressure but the company was recognized by the Chattanooga-Hamilton County Air Pollution Control Board as one of four companies that have met 1974 regulations 2 years ahead of schedule. Legal actions against General Portland in Tampa, Fla., by the State were settled. When construction is completed by mid-1973, the Tampa plant should be in compliance with all regulations and the litigation instituted by the county should be resolved.

While Nevada Cement Co. and its parent firm, Centex Corp., Dallas, Tex., have appealed to the Nevada Supreme Court to reverse a district court's decision awarding $1,865,298 to 85 residents in Fernley, Nev., a second suit was filed on March 6, 1972. This suit was filed by 9 individuals in the District Court of Lyons County purportedly as a class action alleged to include some 2,000 persons seeking nearly $43 million.

In November, Harris County, Tex., as plaintiff, brought suit against Ideal Cement Co., alleging that at its Galena Park cement plant operations, wastes were discharged into waters of the State of Texas in contravention of its waste discharge permit and of orders, rules, and regulations of the Texas Water Quality Board. Representatives of the Midcoastal Sportsmen's Club and the National Audubon Society filed protests against an application by Lone Star Industries Inc. for additional permits to dredge oyster shells at several new locations in San Antonio Bay. Only conditional permits were being issued while awaiting results of a study being conducted by Texas A&M University in cooperation with the Texas Parks and Wildlife Department. The study was ordered by the Corps of Engineers because of protests in past years over possible damage to the environment resulting from shell dredging in Texas coastal waters.

Keystone Portland Cement Co. was helping maintain a regular flow in Monocacy Creek by pumping water into it from its Bath, Pa., quarry. Sections of the creek in Northampton County had been dry and the quality of the quarry water is good so it posed no danger to aquatic life. National Portland Cement Co. filed a permanent plan to treat the effluent from the wet scrubber system at its Brodhead, Pa., plant to assure that water will not harm aquatic life in Monocacy Creek. The company plans to donate $10,000 to the State of Pennsylvania for the improvement of streams.

At its Permanente, Calif. operation Kaiser Cement & Gypsum Corp. granted the Santa Clara County Board of Supervisors an easement deed guaranteeing preservation of Permanente Ridge against quarrying below the 1500-foot level to maintain the scenic backdrop for county residents. The company retained a landscape architectural firm to develop a program of revegetation for sections of the quarry in which mining was completed. The 5-year program calls for the use of oaks, California Bay trees, manzanita, and other shrubs, trees, and grasses native to the surrounding area. While beautification work is undertaken by companies in the U.S., employees at all levels in the cement plants in Russia were expected to contribute at least 20 hours annually for planting. The Angarsk cement plant received the Government's "Protection of Russia's Nature" medal for landscaping the grounds with 40,000 trees, 50,000 shrubs, and flowerbeds. Waste heat from the kilns was utilized in greenhouses to grow vegetables. Ciments Lafarge's new plant at Port la Nouvelle received an award worth F10,000 from the French Minister of the Environment for protection of the landscape and dust and noise control. Twelve percent of the capital cost of this plant was spent on pollution control.

After conducting waste reclamation tests using an idle kiln at Alpha Portland Industries' old plant in LaSalle, Ill., All American Environmental Control Corp. (AENCO) of Wilmington, Del., purchased the idle Lehigh Portland Cement Co. Fordwick plant near Craigsville, Va. AENCO proposed to solve the Washington, D.C., metropolitan area solid waste disposal problem by processing at least 500 tons of refuse a day. In addition to reclaiming metallic wastes, AENCO planned to start a mushroom growing center using constituents of the processed waste as compost. Despite public clamor by ecologists and environmentalists about solid waste disposal, no one in the Nation's Capital was willing to supply waste to operate the plant. Solid wastes from the metropolitan areas of Baltimore, Md., and Richmond, Va., could not be obtained either.

A court action that could adversely affect cement sales in the construction sector occurred on September 21 when the California Supreme Court, in a 6 to 1 decision, decreed that State and local governmental agencies must file written environmental impact statements on applications for private as well as public construction projects that may affect the environment under the State Environmental Quality Act. The decision will allow citizens to sue to halt any significant private construction project that doesn't have an environmental impact study. Acting on the advice of city attorneys, many communities curtailed or completely stopped the issuance of building permits, even for repairs to existing structures, pending interpretation of the Court's ruling or action by the State Legislature. Other States were expected to follow California's lead.

EPA testimony at the Price Commission Hearing in Houston, Tex., estimated that electrostatic precipitators cost about $1 million each and fabric bag dust collectors cost approximately $600,000 each. Although the following lists are not complete they give an indication of the millions of dollars expended or committed by the cement industry for air pollution control equipment and installation.

Electrostatic precipitators were installed or under construction by the following companies, with the number in parentheses: Alpha Portland Industries, Inc. at Birmingham, Ala. (2), and Jamesville, N.Y. (1); Arkansas Cement Corp. at Foreman, Ark. (3); Ash Grove Cement Co. at Louisville, Neb. (1); Dundee Cement Co. at Dundee, Mich. (4); General Portland Inc. at Chattanooga, Tenn. (1), and Fort Worth, Tex. (1); Hawaiian Cement Corp. at Barber's Point, Hawaii (1); Ideal Cement Co. at Knoxville, Tenn. (3), Okay, Ark. (2), Portland, Colo. (2), Devils Slide, Utah (2), and Trident, Mont. (1); Lone Star Industries, Inc. at Birmingham, Ala. (1), and New Orleans, La (2); Louisville Cement Co. at Bessemer, Pa. (1); Marquette Cement Manufacturing Co. at Oglesby, Ill. (1); National Cement Co. Div. of Mead Corp. at Ragland, Ala. (1); Columbia Cement Co. Div., PPG Industries, Inc., at Zanesville, Ohio (2); and Santee Portland Cement Co. at Holly Hill, S.C. (3).

Glass baghouse dust collectors were installed or were under construction at kiln operations by the following companies, with the number in parentheses: Coplay Cement Manufacturing Co. at Egypt, Pa. (6); Giant Portland Cement Co. at Harleyville, S.C. (2); Hawaiian Cement Co. at Barber's Point, Hawaii (1); Kaiser Cement & Gypsum Corp. at Permanente, Calif. (2), and Lucerne Valley, Calif. (3); Martin Marietta Cement at Buffalo, Iowa (1), and Calera, Ala. (2); and Whitehall Cement Mfg. Co. at Cementon, Pa., replaced an electrostatic precipitator with a glass baghouse.

Air and water pollution control equipment was installed or under construction by the following companies with dollar values in millions, if announced: American Cement Corp. at Detroit, Mich. (3.1); Colonial Sand and Stone Co. at Kingston, N.Y. (2.5); Gifford-Hill & Co. Inc. at Midlothian, Tex., and Harleyville, S.C. (3.5); Kaiser Cement & Gypsum Co. at Waianae, Hawaii (0.4); Lehigh Portland Cement Co. at Alsen, N.Y. (4.0), and Mason City, Iowa (2.0); Louisville Cement Co. at three plants (4.4); Marquette Cement Manufacturing Co. at several plants (6.7); Medusa Corp. at Clinchfield, Ga. (3.9); Huron Portland Cement Div. of National Gypsum Co. at Alpena, Mich. (2.5); OKC Corp. at Pryor, Okla., and New Orleans, La.; Universal Atlas Cement Div. of United States Steel Corp. at Hannibal, Mo., Waco, Tex., and Independence, Kans.; and Wyandotte Cement, Inc., at its grinding plant in Wyandotte, Mich. (0.75).

DOMESTIC PRODUCTION

PORTLAND CEMENT

Manufacturers in the United States and Puerto Rico produced 77,378,000 tons of clinker and imported 1,691,000 tons of foreign clinker to grind an alltime record 80,744,000 tons of portland cement. Domestic producers shipped 81,432,000 tons of portland cement which included 1,512,000 tons of imported cement. Stocks increased about 600,000 tons. In addition to the imported cement shipped by domestic manufacturers, 1.6 million tons of portland cement was imported and shipped or used by others not producing cement in the United States and Puerto Rico.

Production Capacity.—Four new kilns were brought into production with a combined annual capacity of 1.5 million tons, and five old kilns were reactivated at four plants in 1972. However, 13 old kilns were permanently removed from production at four plants by yearend and the total annual production capacity remained virtually the same as in 1971.

At yearend 461 kilns were in operation at 169 plants in 41 States and Puerto Rico with an estimated 24-hour-daily clinker production capacity of 256,000 tons. An average of 31 days downtime was reported for kiln maintenance and replacing refractory bricks, so based on 334 days of operation, the apparent annual clinker production capacity of the industry was 85.4 million tons.

In addition to 169 clinker-producing plants, including eight white cement facilities, six plants operated grinding mills only, on imported, purchased, or interplant transfers of clinker. Information was not collected on grinding capacity, but the total in the United States and Puerto Rico was estimated to be 94 million tons.

The following tabulation shows the daily clinker production capacities of cement plants in the United States and Puerto Rico, grouped according to relative size:

Daily clinker capacity, December 31

Short tons per 24-hour period	Number of plants [1]	Kilns [2]	Total capacity	Percent of total capacity
1971:				
Less than 600	6	10	2,671	1.0
600 to 1,150	49	98	40,455	15.8
1,150 to 1,700	65	170	88,927	34.6
1,700 to 2,300	28	95	54,303	21.1
2,300 to 2,800	11	37	28,734	11.2
2,800 and over	11	56	41,772	16.3
Total	170	466	256,862	100.0
1972:				
Less than 600	10	17	4,860	1.9
600 to 1,150	47	93	40,646	15.9
1,150 to 1,700	60	175	80,808	31.5
1,700 to 2,300	29	78	55,384	21.6
2,300 to 2,800	9	31	22,646	8.8
2,800 and over	14	68	52,073	20.3
Total	169	461	256,417	100.0

[1] Includes white-cement-producing facilities.
[2] Total number in operation at plants.

Capacity Changes.—On March 30th, Texas Industries, Inc., started to produce clinker from its new fourth kiln at Midlothian, Tex. The 12-foot by 450-foot wet-process kiln increased plant annual capacity by 301,000 tons to a total of 1.2 million tons. Also included in the expansion was a 12-foot by 33-foot finish-grinding mill completed in April. Gifford-Hill Portland Cement Co. increased the annual capacity of its Midlothian plant to 846,000 tons with the addition of a third kiln. The new 12-foot by 450-foot kiln with an annual capacity of 282,000 tons went on stream in July. Hawaiian Cement Corp. installed a 12-foot by 191-foot kiln equipped with a suspension preheater and the first modern planetary clinker cooler in the United States. The $6 million expansion project completed in July 1972 near Ewa Beach, Oahu, increased annual clinker production capacity by 271,000 tons to a total of 451,000 tons. The original smaller kiln may be used for specialty cements. Additional grinding capacity was planned.

In September, Arizona Portland Cement Co. started operating a new kiln with a suspension preheater, the largest presently installed in the U.S., at its Rillito, Ariz., plant. The kiln, 15 feet in diameter by 235 feet long, has a daily production capacity of 1,880 tons. One old kiln was shut down permanently and the other two older kilns were in the process of being modernized, particularly in the dust-collecting facilities. A new finish-grinding mill was being installed. When completed in January 1974, the plant will have an annual capacity of 1.15 million tons compared with 500,000 tons in 1971 prior to the new construction. Included in the $20 million expansion and modernization program was a 1000-ton-per-hour Hazemag impact crusher; a 30-inch, 4.8 mile long belt conveyor totally enclosed; an enclosed raw material storage area; and a 15.5-foot by 21-foot, 3000-hp raw-grinding mill. An expansion to the feed end of a kiln at the Martin Marietta Corp. plant in Atlanta, Ga., increased annual capacity by 75,000 tons.

In addition to the four new kilns becoming operational during the year, five old kilns were reactivated. In March, Coplay Cement Manufacturing Co. purchased the Giant Portland Cement Co. plant at Egypt, Pa., that was closed in 1970. The Egypt plant is adjacent to the company's Coplay plant. Two of the eight kilns with a combined annual capacity of 112,000 tons were placed into operation by midyear. Installation of preheaters on kilns at the company's Nazareth, Pa., plant increased output capacity by 64,000 tons. A kiln shut down several years ago at Alsen, N.Y., was reactivated by Lehigh Portland Cement Co. and increased production capacity by 20%. Oregon Portland Cement Co. reactivated the older kiln at its Lime, Oreg. plant and installed a new coal mill at its operation. Allentown Cement Div. of National Gypsum Co. reactivated an old kiln at its Evansville, Pa., plant.

Puerto Rican Cement Co., Inc. converted its white cement facilities at Ponce, P.R., to gray cement production at yearend.

In April, Lone Star Industries, Inc., discontinued kiln operations at its Norfolk, Va., plant, but continued to operate grinding mills on imported clinker. In October, Peerless Cement Co. Div. of American Cement Corp. suspended manufacturing operations at its Brennan Avenue plant in Detroit, Mich. Future plans are to incorporate the 16-year-old facility into the new Detroit plant complex. The company also closed the Port Huron, Mich., plant at yearend.

Planned Expansions and New Plants.—Twelve plant modernizations and expansions were under construction and scheduled for completion in 1973. At Oglesby, Ill., Marquette Cement Manufacturing Co. was replacing eight old kilns shut down in December with one kiln that would increase the annual capacity by 28,000 tons to a total of 771,000 tons when completed in January 1973. One new 13-foot by 43-foot, 4400-hp finish-grinding mill replaced 12 old mills. In a $15 million project Glens Falls Cement Co., Div. of the Flintkote Co. was converting its Glens Falls, N.Y., plant from wet to dry process with the installation of a 15-foot-diameter by 235-foot-long kiln equipped with a Miag 220-foot-high, four-stage counterflow suspension preheater. The new kiln, expected to be operational by July 1973, will increase the clinker production capacity by 244,000 tons to a total of 564,000 tons.

Giant Portland Cement Co. was installing a new fifth kiln at Harleyville, S.C., that will increase annual capacity by 280,000 tons to a total of 1,032,000 tons when completed in mid-1973. In addition to the 12.5-foot diameter/11.25-foot-diameter/13-foot-diameter by 425-foot-long wet-process kiln, a 10-foot-diameter by 32-foot-long raw-grinding mill, and a 12-foot by 32-foot finish-grinding mill were included in the $9 million expansion program. The company plans to discontinue operation of the oldest kiln. Ideal Cement Co. was converting the Trident, Mont. plant from dry to wet process with the installation of one new 12-foot-diameter by 450-foot-long kiln to replace four old kilns. When completed in April 1973, the annual capacity will be increased by 38,000 tons to 329,000 tons. Computer controls were included in the $12 million expansion project. At Speed, Ind., Louisville Cement Co. was replacing three old kilns with one new kiln 13 feet/15 feet in diameter by 500 feet long. The clinker production capacity will be increased by 197,000 tons to a total of 1,109,000 tons when completed in the first quarter of 1973.

Monarch Cement Co. started construction of a new dry process kiln with a preheater at Humboldt, Kans., to replace some old kilns. The 12-foot-diameter by 165-foot-long kiln with a daily capacity of 800 tons was scheduled for completion in late 1973. A second identical kiln was planned for operation in 1975. A new Preliminator grinding mill was installed during the year. The Phoenix Div. of American Cement Corp. completed an expansion program including a 1500-hp finish-grinding mill at Clarkdale, Ariz., that increased the annual capacity by 150,000 tons to a total of 660,000 tons. At Miami, Fla., General Portland, Inc., was modifying two kilns 11.5 feet in diameter by 425 feet long by replacing sections of the kiln shell at the feed end with enlarged shells 13 feet in diameter by 126 feet long. The project, scheduled for completion in 1973, will increase the annual clinker production capacity by 56,000 tons to a total of 483,000. Coplay Cement Manufacturing Co. started installation of a glass baghouse in order to reactivate six remaining kilns at its recently purchased Egypt, Pa., plant, now an integral part of the Coplay plant. When completed by the summer of 1973, the annual capacity of the new plant complex will be increased by 260,000 tons to a total of 1,350,000 tons. Lehigh Portland Cement Co. planned to reactivate two old kilns at Alsen, N.Y., when construction to meet environmental standards is completed in 1973.

Construction was started on a kiln modification project by OKC Corp. at its Pryor, Okla., plant that will increase annual capacity by 75,000 tons to a total of 451,000 tons when completed in late 1973. The company also started a $15 million expansion project at its New Orleans, La., plant. Annual capacity will be increased by 357,000 tons to a total of 677,000 tons by the addition of a 14-foot/12.5-foot-diameter by 460-foot-long kiln and two grinding mills, 12 feet by 36 feet, one for raw feed and the other for finished cement. Completion was scheduled for late 1973.

San Juan Cement Co. started construction to expand its plant in the Barrio Espinosa area of Dorado near San Juan, P.R. The wet process kiln 12 feet/13.5 feet in diameter by 471 feet long will increase the annual capacity by 282,000 tons to a total of 752,000 tons when completed. Equipment to be installed also includes an 11-foot by 38-foot raw-grinding mill and a 13-foot by 42-foot, 4000-hp finish-grinding mill.

Three new plants were under construction or planned for operation in 1974. Gifford-Hill Portland Cement Co. started construction of a new $26 million plant at Harleyville, S.C. The 15-foot-diameter by 220-foot-long kiln equipped with a suspension preheater will have an annual capacity of 564,000 tons when completed in January 1974. Also scheduled for operation in January is a $15 million plant at Columbus, Miss., by Texas Industries, Inc. Initial capacity will be 376,000 tons, with provisions to expand the annual capacity to 1.1 million tons. In July 1972 Centex Cement Corp. purchased the old plant of Alpha Portland Industries, Inc. at LaSalle, Ill. The company was installing a 13.5-foot-diameter by 190-foot-long kiln equipped with a four-stage suspension preheater and an 11-foot by 34-foot finish-grinding mill. The plant, scheduled for operation in early 1974, will have an annual capacity of 376,000 tons.

Plans for an additional 13 plant modernization and expansion program were announced. These were in various stages of planning and construction, and completion was scheduled for 1974 or 1975. Medusa Corp. started construction on a $13 million expansion project at Clinchfield, Ga. A

15-foot-diameter by 220-foot-long kiln equipped with a suspension preheater having an annual capacity of 560,000 tons will be installed along with grinding mills. Completion was scheduled for January 1974. Old kilns with a combined capacity of 200,000 tons will be retired, so that the annual clinker production capacity will be increased by 360,000 tons to a total of 752,000 tons. Santee Portland Cement Co. was expanding its Holly Hill, S.C., plant with the addition of a new 18 feet in diameter by 580 feet long kiln. Also included in the $12 million project were an 11-foot by 38-foot raw-grinding mill and a 13-foot by 46-foot finish-grinding mill. When completed in early 1974, the annual capacity will be increased by 752,000 tons to a total of 1,128,000 tons. The Diamond-Kosmos Cement Div. of the Flintkote Co. planned a $25 million modernization and expansion of its Kosmosdale, Ky., plant for completion in mid-1974. The new kiln, with an annual capacity of 658,000 tons, will replace four old kilns in operation now and six old kilns shut down in 1970. This will increase the plant's clinker production capacity 50% from the present capacity and 10% above the 1970 capacity.

At Portland, Colo., a $25 million expansion project was under construction for Ideal Cement Co. that will double the annual capacity to 936,000 tons. Equipment to be installed includes a 16.5-foot-diameter by 500-foot-long kiln, wet process, and three 11-foot by 34-foot grinding mills, one for raw feed and two for finished cement. Completion was scheduled for mid-1974. Pennsuco Cement and Aggregates, Inc., subsidiary of Maule Industries, Inc., completed installation of a new 4,000-hp, 13-foot by 43-foot finish-grinding mill in November 1972 at its plant near Miami, Fla., and started operating it on imported clinker. A new wet-process kiln will be installed to increase annual clinker production capacity from 432,000 tons to 1,222,000 tons when completed in 1974. The company has ordered a 6,300-hp grinding mill to be installed early in 1975 that will increase the grinding capacity from 1,222,000 tons to 2,162,000 tons. Southwestern Portland Cement Co., subsidiary of Southdown, Inc., started construction of new facilities at Fairborn, Ohio, to replace the 47-year-old plant. The $17 million project includes a 15-foot-diameter by 220-foot-long kiln equipped with a suspension preheater. The kiln has an annual capacity of 620,000 tons. When completed in 1974 the company expects a 20% increase over present production output with a 40% decrease in fuel consumption.

Ash Grove Cement Co. planned to replace five old wet-process kilns built in 1929 with a new dry-process kiln at its plant in Louisville, Neb. When completed in late 1974 or early 1975 the annual capacity will be increased by 282,000 tons to a total of 936,000 tons. Whitehall Cement Manufacturing Co. planned to install a kiln equipped with a preheater and with an annual capacity of 235,000 tons. The $9 million expansion program, including a 3,500-hp finish-grinding mill scheduled for completion by mid-1975, will increase the annual capacity of the Cementon, Pa., plant by 45%.

Puerto Rican Cement Co. was planning to construct a $30 million plant near Toa Alta, about 15 miles southwest of its San Juan plant. This will replace the four kilns at the 33-year-old San Juan facility having a combined annual capacity of 564,000 tons. The near depletion of limestone reserves at the old plant and the uneconomic feasibility of meeting the Federal Air Pollution control standards by 1975 were the compelling reasons for the new plant.

Coplay Cement Manufacturing Co. planned additional kiln capacity in 1975 at its Coplay, Pa., plant. This would bring the combined total annual clinker production capacity of the Coplay-Egypt plant complex to 1,430,000 tons. Monolith Portland Cement Co. installed a new crusher and conveyor belt at its quarry near Tehachipi, Calif., completing the second phase of a modernization program. A 15-foot/17.5-foot-diameter by 520-foot-long wet-process kiln with an annual capacity of 470,000 tons was scheduled for operation in 1974. Five old kilns will be retired and a second kiln will double the above capacity when installed in 1976. Southeastern Materials, Inc., planned to build a $28 million cement plant at the Pennsuco Industrial Center near Miami, Fla. The dry-process kiln equipped with a four-stage suspension preheater would have a daily capacity of 1,000 tons of clinker. Originally scheduled for completion in 1975, construction was initially delayed because of the indecision of the Dade County Pollution Control Board to issue a permit. Rinker Materials Corp. of West Palm Beach, Fla., owns a large share of the company.

Cement Grinding Facilities.—Clinker-grinding facilities were becoming increasingly important as quasi cement production units. The old Jefferson Avenue plant of American Cement Corp. in Detroit, Mich., purchased by Detroit Edison Co., was sold in June 1972 to Edward C. Levy Co. operating under the name Jefferson Marine Terminal. Cement will be produced by grinding clinker imported from Sweden and Canada in early 1973. The Norfolk, Va., plant of Lone Star Industries became a grinding facility when the kilns were shut down in April, and now operates on imported clinker. Pennsuco Cement and Aggregates, Inc., started grinding imported clinker in November at its plant near Miami, Fla. with a new grinding mill rated at 1,800 tons a day. When the new kiln is completed in 1974, the company plans to install an additional grinding mill in 1975 with an annual capacity of 940,000 tons to operate on imported clinker. Pesco Cement Co., a subsidiary of National Portland Cement Co., planned to install an 11-foot by 34-foot grinding mill at Bradenton's port, Manatee, Fla. The new plant, with an annual capacity of 282,000 tons was expected to be in operation by yearend 1973, grinding clinker imported from Europe.

River Cement Co. was installing a 13-foot by 34-foot, 3,500-hp finish-grinding mill with an annual capacity of 178,000 tons for completion in late 1973. This addition will bring the grinding capacity up to the clinker production capacity of 1,128,000 tons at its Festus, Mo., plant. Hawaiian Cement Corp. planned to install additional grinding facilities at Barber's Point, Hawaii to increase the present grinding capacity of 185,000 tons to equal the clinker production capacity of 450,000 tons. Capitol Cement Div. of Capitol Aggregates, Inc., installed a new 12-foot by 33-foot finish mill at its plant in San Antonio, Tex. Gulf Coast Portland Cement Co. was installing an 11-foot by 34-foot finish mill at its plant in Houston, Tex. Completion was scheduled for mid-1973. At Bath, Pa. Keystone Portland Cement Co. installed a new raw-grinding mill in late 1972 and converted the old raw mill to finish grinding. Missouri Portland Cement Co. was installing a new finish mill at its Joppa, Ill., plant. The 13-foot by 32.75-foot, 3,000-hp mill was scheduled for operation in June 1973.

Monarch Cement Co. completed installation of a new $800,000 Preliminator mill at its plant in Humboldt, Kans. Arizona Portland Cement Co. was replacing five 500-hp finish mills with one 14-foot by 24-foot, 3,000-hp grinding mill. When completed in December 1973, the annual grinding capacity of the Rillito, Ariz. plant will be 1,128,000 tons.

In addition to these grinding plants the following companies operate grinding facilities on imported, purchased, or interplant transfer of clinker: Wyandotte Cement, Inc., at Wyandotte, Mich.; Universal Atlas Cement Div. of United States Steel Corp. at Milwaukee, Wisc.; Huron Cement Div. of National Gypsum Co. at Superior, Wisc.; Allentown Cement Div. of National Gypsum Co. at West Conshohocken, Pa.; and G. & W. H. Corson, Inc., at Plymouth Meeting, Pa.

MASONRY CEMENT

Shipments of masonry cement again reached an alltime high of 3,850,000 tons, an increase of 13% over the 1971 record. The unit price increased $1.23 a ton to $26.52 and the total value increased 19% to $102.1 million. By yearend 116 plants were manufacturing masonry cement in the United States. Four plants produced masonry cement exclusively: Riverton Lime & Stone Co., Inc., Riverton, Va.; M. J. Grove Lime Co. Div. of Flintkote Co., Frederick, Md.; Cheney Lime and Cement Co., Allgood, Ala.; and Martin Marietta Cement, Birmingham, Ala. Riverton reported increased sales of colored masonry cement. 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. Masonry cement imports were 103,855 tons in 1972, nearly double the 1971 total.

ALUMINOUS CEMENT

Lone Star Lafarge Co. was constructing a $3 million grinding facility to produce calcium aluminate cement at Norfolk, Va. Equipment to be installed includes an 8.5-foot by 40-foot grinding mill and a 1,000-

ton-per-hour clinker receiving facility. Completion was scheduled for the spring of 1973. Lone Star Industries, Inc., in a joint venture with Ciments Lafarge, S.A., of France and Lafarge Organisation, Ltd., of England, will import clinker and market the cement under the name "Fondu." The Aluminum Co. of America operates a calcium aluminate cement plant at Bauxite, Ark., and Universal Atlas Cement Div. of United States Steel Corp. operates a calcium aluminate refractory cement plant at Gary, Ind.

TRANSPORTATION

Many companies reduced their marketing area in order to lower transportation and distribution costs through selective marketing during the President's Phase II price freeze. Prior to this, about 20% of the cost of cement to the buyer represented delivery expense from the mill. Testimony at the Price Commission hearing indicated that transportation costs could be as much as 25% of the delivered price.

Some companies closed cement distribution terminals to reduce costs, while others were building terminals for the same reason. Lehigh Portland Cement Co. closed its distribution terminal at Jacksonville, Fla., and General Portland Inc. was planning construction of a terminal adjacent to deep water in 1973 at Jacksonville. Lehigh opened the former Lone Star Industries terminal at Port of Pasco, Wash., in July. Ideal Cement Co. permanently discontinued its distribution facilities at Eugene, Oreg. After losing a barge at sea, Atlantic Cement Co. sold its terminal in Florida. The company added four silos at its Boston, Mass., distribution facility, increasing storage capacity 30,000 tons. Alpha Portland Industries Inc. sold its terminal in Chicago, Ill., to Centex Cement Corp. in July. Penn-Dixie Cement Corp. closed terminals at Memphis, Tenn., Buffalo, N.Y., and Minneapolis, Minn., during the year. South Dakota Cement Commission had a new $700,000 distribution center under construction in Sioux Falls, S. Dak. In addition to four silos with a total capacity of 3,760 tons the facility will have sacking equipment. Wyandotte Cement, Inc., was building a new bulk-storage terminal along the waterfront in Buffalo, N.Y. Hawaiian Cement Corp. completed a bulk-storage terminal at Kahului, Maui, with a capacity of 2,250 tons. A similar facility was under construction at Kawaihae, Hawaii, for completion in late 1973. An additional terminal was planned for the Island of Kauai.

Kaiser Cement & Gypsum Corp. completed a new $345,000 distribution plant at Spokane, Wash., near the site of the 1974 World's Fair. The company replaced the barge *Anchorage,* which sank late in 1971 off the coast of Alaska, with a new barge, *Permanente 272,* having a capacity of 6,000 tons. The vessel, acquired early in 1972 at a cost of $1.2 million, transported cement between Kaiser's Pacific Northwest and Alaska distribution facilities. The company purchased cement in Asia and marketed 56,000 tons in Australia and 94,000 tons in Guam, transporting it in two company-owned ships with combined capacity of 11,000 tons. Jalaprathan Cement Co. (35% owned by Kaiser) constructed a new bulk terminal on the waterfront in Thailand. In May, Kaiser Cement & Gypsum Corp. announced plans for construction of a $600,000 distribution facility at Cabras Island, Guam. Storage capacity will be 6,600 tons. In late spring, Missouri Portland Cement Co. received four bulk cement barges that were ordered in 1971 for river transport of cement to distribution terminals. A/S Norcem, Norwegian exporter to the United States, ordered four new cement bulk carriers valued at $25 million. Dundee Cement Co. was increasing its barge fleet from 34 to 44 units.

The Chicago and North Western Railroad inaugurated a "commoditrain" service to determine the economic and operating efficiency for the railroad and the customers on movement of cement during the construction season. The single-commodity trains were making five round trips a week from two cement producers in Mason City, Iowa, to distribution terminals in Burnsville, Minn., carrying more than 45,000 tons of cement.

Construction activity in Puerto Rico was affected by an island-wide transportation strike early in the year.

Despite costly shipping strikes, Hawaiian shipments increased 7%.

In the United States, trucks continued to haul most of the cement delivered to customers. However, railroads and barges transported most of the cement shipments from plants to distribution terminals. Trucks hauled 83% of the total cement shipments to customers, railroads 16%, and the remainder was transported by water. Nevertheless, waterborne transportation was becoming increasingly more important. The cost of shipping by barge was in the magnitude of 0.3 cents a ton-mile compared with 1.5 cents a ton-mile by rail and 6.0 cents a ton-mile by truck. Plants located adjacent to deep water were able to (1) receive raw materials, such as limestone from Texada Island, Canada, and aragonite from the Caribbean near the Island of Bimini; (2) import foreign clinker to supplement kiln production, such as at plants in Washington and Florida, or replace kiln production, such as at grinding plants in Michigan and Virginia; and (3) ship cement by barge or boat to domestic distribution centers and foreign countries.

More than 150 ships were in use throughout the world as bulk cement carriers excluding vessels used on rivers or inland waters only, but including ships on the Great Lakes. Only a half-dozen ships were in the 20,000-ton class or slightly larger. About 15 ships had a capacity ranging between 10,000 to 20,000 tons. In the fall of 1972, Ube Industries received the Nakaoki Maru No. 2, a 528-foot-long ship with a capacity of 20,700 deadweight tons (d.w.t.). The vessel had an unloading capacity of 2,000 tons an hour. Onada Cement Co. ordered a 21,000-ton ship for delivery in August 1973. Although the trend is toward larger ships, the cement carriers will be much smaller than the 150,000-ton ore/bulk/oil vessels now in use.

In addition to truck, rail, and barge, Inland Cement Industries Ltd. in Edmonton, Canada, shipped cement by air. Bulk cement in amounts up to 19½ tons have been loaded on L–100 and L–200 Hercules cargo aircraft.

CONSUMPTION AND USES

Shipments of cement into various States are considered to be an index of consumption. Portland cement consumption reached a record high, surpassing the 1971 record by 3%. Although consumption increased in 37 States and shipping districts, 18 had lower consumption. Spurred by an unprecedented construction boom, consumption in Florida increased over 1 million tons. Other States and shipping districts with large increases were: Texas, 627,000 tons; Georgia, 334,000 tons; New York metropolitan area, 271,000 tons; North Carolina, 265,000 tons; and western New York, 255,000 tons. The following States had shipment increases ranging between 170,000 and 225,000 tons: Virginia, Colorado, Arizona, Louisiana, and Oklahoma. Shipment increases exceeded 100,000 tons in Utah, Mississippi, Nebraska, southern California, Oregon, and Alabama. The greatest decrease in consumption was in Illinois, with a decline of 307,000 tons, followed by Missouri, 228,000 tons; northern California, 181,000 tons; eastern New York, 138,000 tons; eastern Pennsylvania, 136,000 tons; Washington, 125,000 tons; and Michigan, 118,000 tons.

Producers of ready-mix concrete were the primary customers for portland cement, receiving 64.4% 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 8.4% of the total cement consumed. Building materials dealers received 7.8% of the shipments; other contractors received 2.8%; Federal, State, and other government agencies purchased 0.3%; and 2.5% went for miscellaneous uses.

New construction activity, accounting for 11% of GNP, reached another record high in 1972, an increase of 13% over last year's record. Both single-unit and multi-unit housing construction reached new peaks. Nearly three-fourths of the new housing units were inside metropolitan areas. The South continued to dominate the residential boom, and Florida and California were the leading States. Commercial construction to provide facilities to serve the new residential areas advanced 6%. In sharp contrast, private nonresidential building decreased 3%. Public building construction was down 7%, highways and street construction decreased 6%, and sewer construction declined 12%. The value of public construction in constant dollars declined for the fourth straight year, and industrial construction declined for the third successive year. Water supply facilities construction increased 2%.

Despite record production and soaring imports, there was a shortage of cement in Florida and other Southern States, where producers allocated cement to customers. Fuel shortage at some plants and curtailed cement production resulting from a proliferation of environmental control regulations in general coincided with the construction boom in the Southeast to cause the tight supply situation. This was heightened by a continued demand shift to concrete products due to the rapid price increases of lumber and wood products.

PRICES

The average mill value[2] of portland cement (all types) was $20.31 a ton in 1972, an increase of $1.57 a ton. The mill value ranged from lows of $16.32 in Puerto Rico and $18.76 in Kansas to highs of $26.70 in Hawaii and $24.65 in Florida. The average mill value for gray cement increased 8% to $20.03 a ton. White cement increased $3.78 a ton to $45.31.

Price controls imposed under Phase II of the Economic Stabilization Act were of great concern to the cement industry because market conditions that caused prices to remain virtually unchanged for a decade had only recently begun to improve. However, within the constraints of the price control program in effect during 1972, many companies were able to implement limited price increases to partially offset increased costs. Price increases granted to individual companies by the Price Commission ranged up to $2.60 a ton. But in many instances part or all of the increase was ineffective because of competitive pressures from major cement producers in the market area whose prices were held down by the same rule. The Price Commission denied a request for industry wide price relief, so the PCA appealed to President Nixon to reconsider its request. In response to this appeal the Price Commission held a public hearing in Houston, Tex., October 6, 1972, with two of the six Commissioners attending. No decision was made by yearend.

The Corps of Engineers uses about 5 million tons of portland cement a year for civil works and military construction. Although the Corps does not purchase cement itself, it follows the price trend in the bids. However, the bid price is not the price quoted by the supplier, but does indicate the price situation in the industry. Examples of 1972 bid prices for a ton of cement for civil works were as follows: West Virginia $45.00 in March, up 51% from November 1971; Alabama $43.80 in June, up 74% from March 1971; Georgia $40.00 in March, up 50% from August 1970; Montana $36.00 in April, up 25% from February 1971; Colorado $32.00 in January, up 5% from November 1970; and Ohio $28.00 in February, up 9% from September 1970. Much of the cost escalation in the southeast was caused by a regional cement shortage, and bid prices anticipated higher freight charges on cement shipped from sources in other parts of the country.

According to Engineering News-Record, December bulk mill prices ranged from $20 a ton in Independence, Kans., to $31.60 a ton in Waianae, Hawaii, with $27.20 reported for Demopolis, Ala. All prices were subject to cash discounts. Bagged cement prices were $4 to $14 a ton higher than bulk prices. 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 1972 average for bulk cement was $25.25 a ton compared with $23.94 in December 1971. In the 20-city survey, bulk prices ranged from a low of $22 a ton in Pittsburgh, Pa., to a high of $28.20 a ton in Denver, Colo. Masonry cement averaged $30.75 a ton in December 1972 and ranged from $25.20 a ton in New York City and Minneapolis, Minn., to $41 a ton in Cleveland, Ohio.

[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.

Consumer Services Administration of the Commonwealth of Puerto Rico approved a selling price increase from $1.30 to $1.35 a bag of cement at the producers' level on December 1, 1972, and another increase of 5 cents a bag effective December 15. Because Puerto Rican Concrete Mixers Association firms negotiated contracts with customers on the basis of the first increase, the Puerto Rican Cement Co. postponed the second increase until April 1, 1973. San Juan Cement Co. increased the price 5 cents a bag on August 1, 1972.

Many producers suggest the only solution to the problem of pollution control expenditures is to increase prices for cement so that pollution control costs are spread among all who are financially or commercially interested in the utilization of the cement.

Price increases reported by most companies were not sufficient to offset rising production costs. Fuel oil, natural gas, and low-sulfur coal were all in short supply, so fuel costs increased. Power, labor, equipment, and materials costs also rose. Many companies reduced cash discounts and reduced their marketing area to lower distribution costs.

Some companies importing cement from Canada reported low profit on handling this cement compared with profits on cement imported from other countries. Cost-price escalations in foreign countries were also becoming a serious concern.

FOREIGN TRADE

Although hydraulic cement exported from the United States in 1972 declined 8% in quantity the value increased 7%. Four countries—Canada, Leeward and Windward Islands, Netherlands Antilles, and Mexico—received 80% of the 100,889 tons of cement exported to 73 countries. Exports were the lowest since 1963.

Portland cement and clinker imported from 22 countries for consumption in the United States and Puerto Rico soared to another alltime high of 4.9 million tons, surpassing the 1971 record by 59%. Imports were more than triple those of any year from 1850 through 1968. The largest increase was in Florida, where imports nearly doubled to alleviate a cement shortage caused by an unprecedented construction boom.

Clinker comprised 34% of the total imports in 1972 compared with 24% in 1971; 15% in 1970; and less than 10% each year from 1961 through 1969. An increasing number of plants were operating entirely or partially on imported clinker—two plants in Detroit, Mich., one each in Norfolk, Va., Miami, Fla., and Seattle, Wash. were among those responsible for increased clinker imports during 1972.

Canada continued to be the leading exporter, supplying 43% of the imported cement and clinker, followed by the Bahamas with 19%; Norway, 12%; the United Kingdom, 9%; Mexico, 6%; and France 5%.

On January 1, 1972, the rate of duty on white, nonstaining portland cement decreased from 1.5 cents to 1.0 cent per hundred-weight including the weight of containers, and the rate of duty for other hydraulic cement and clinker decreased from 0.4 cent per hundred weight to duty free. This was the final stage of annual rate modifications granted by the United States in the Kennedy round of trade negotiations concluded on June 30, 1967, under the General Agreement on Tariffs and Trade (GATT). The statutory import duty for countries that do not have most-favored-nation status was 8 cents per hundred-weight for white, nonstaining portland cement and 6 cents a hundred-weight for other hydraulic cement and clinker.

WORLD REVIEW

About 1,600 clinker-producing cement plants in 133 countries were in operation, with a total annual capacity of 675 million tons. In addition, more than 2,400 very small cement plants were reported operating in many municipalities in the People's Republic of China, accounting for about 40% of the country's estimated 20-million-ton capacity. Numerous new cement plants were under construction or in various stages of planning and financing in many countries. Old plants were being modernized, expanded, or replaced, not only to increase efficiency, but to meet air pollution control demands compelled by a growing concern in many nations for the quality of the environment. Production capacity growth was expected to continue.

The world cement situation continued to be a dichotomy of chronic shortage in many countries in Europe, Asia, and Latin America, while a surplus existed in other countries, such as Argentina, Canada, Italy, and the Philippines. Production costs were increasing in virtually every country. Sharp rises in fuel and power costs were reported increasing in some countries by 50% or more. Wages have increased and transportation costs were up. In many countries, prices were fixed by government regulations.

During 1972, European countries belonging to the European Cement Association (CEMBUREAU) started operating five new plants with a combined annual capacity of 2.2 million tons. In addition, 20 new kilns went into operation with a combined annual capacity of 8.8 million tons. Nine new plants and 14 plant expansions were under construction that will increase the annual clinker production capacity by 13 million tons when completed in 1973.

Abu Dhabi.—Plans were made for construction of a new cement plant at Al-Ain near the mountain of Hafeeth, with an annual capacity of 220,000 tons. Production was scheduled for late 1973.

Algeria.—Three new cement plants under construction with a total capacity of 2.3 million tons were behind schedule. Only the 550,000-ton a year plant at Hadjar-Soud near Annaba will be near completion by the end of 1973.

Angola.—Companhia dos Cimentos de Angola was expanding the Lobito plant from its present annual capacity of 99,000 tons to 220,000 tons.

Australia.—Australia Portland Cement Ltd. started using natural gas, replacing oil and coal at the Geelong plant.

Austria.—Perlmooser Zementwerke A.G. started operating a new kiln at its Rodaun plant with an annual capacity of 530,000 tons. Gmunder Portlandzementfabrik Hans Hatschek A.G. was installing a kiln at its Gmunden plant with an annual capacity increase of 290,000 tons. Completion was scheduled for 1973. Schretter and Cie. was replacing old kilns with a new kiln. When completed in 1973 the annual capacity will be increased by 290,000 tons.

Belgium.—Ciments d'Obourg S.A. was installing a new kiln at its Obourg plant with a daily capacity of 3,000 tons scheduled for operation in the spring of 1973.

Brazil.—Companhia Cimento Vale do Paraiba was installing dry-process equipment at its cement plant in Pedra do Sino, Carandaí, Minas Gerais, to increase the annual capacity by 550,000 tons. Cia. de Cimento Nacional de Minas (Ciminas), a new company formed by international investors including ITT and Holderbank, was constructing a cement plant at Pedro Leopoldo in Minas Gerais with an annual capacity of 1.1 million tons. Cimento Tocantins was constructing a plant in the Distrito Federal near Brasília with an initial annual capacity of 190,000 tons during 1972. Plans were made to increase the annual capacity to 360,000 tons by the end of 1973. Camargo Correa Industrial was completing construction of a plant at Apiaí, São Paulo, with an annual capacity of 660,000 tons. Cia. de Cimento Atol was constructing a cement plant at Santo Antonia da Barra, Alagoas. Cia. de Cimento Itambe was building a plant at Campo Largo, Paraná. Cia. Agro Industrial de Monte Alegre expected completion of its plant with an annual capacity of 100,000 tons in Monte Alegre, Pará, in 1973. Mineração e Cimento Vale do Itajai "Cimenvale" had under construction a plant at Brusque, Santa Catarina. In 1972 Cia. de Cimento Portland Gaucho started operation of its new plant in Municipio de Pinheiro Machado, Rio Grande do Sul, with an annual capacity of 238,000 tons. Cia. de Cimento Portland Mossoró planned construction of a plant at Mossoró, Rio Grande do Norte, for completion in 1974 with an annual capacity of 110,000 tons.

Cia. Ituacu de Calcáreos was constructing a plant at Ituaçu, Bahia, with an annual capacity of 120,000 tons. Cia. Nacional de Cimento Portland started construction of a plant at Cantagalo, Rio de Janeiro, with an annual capacity of 792,000 tons. Industrias de Cimento Portland Cantagalo was building a plant at Macaé, Rio de Janeiro, scheduled for completion in 1973 with an annual capacity of 950,000 tons. Itapetinga Agro-Industrial was building two plants with an annual capacity of 198,000 tons each at Lajes, Rio

Grande do Norte, and at Codó, Maranhão. Serrana S.A. de Mineração was constructing a plant near Jacupiranga, São Paulo, with an annual capacity of 440,000 tons scheduled for operation in 1973. Sociedade de Empreedimentos Industrials Commerciais et Mineração planned construction of a plant at Lagoa Santa Belo Horizonte, Minas Gerais, for completion in 1974 with an annual capacity of 1.1 million tons. Another plant was in the planning stage for Campo Formoso, Bahia.

Bulgaria.—Reconstruction of equipment at the Beli Isvor cement plant near Vratsa will increase annual capacity by 130,000 tons, to 750,000 tons. A new, fifth kiln will be installed that will increase capacity another 350,000 tons to a total of 1.1 million tons.

Cameroon.—The clinker grinding plant completed in January 1971 at Bonaberi near Douala will have its capacity doubled from the present 132,000 tons a year. The grinding plant at Figuil in the north, completed in November 1971, will increase its annual capacity to 50,000 tons.

Canada.—Ten companies continued to operate 24 plants, with a capacity of 14.9 million tons. Canada Cement Lafarge Ltd. was constructing a new plant at Bath, Ontario, with a kiln 19 feet by 22 feet in diameter by 655 long. The plant will have an annual capacity of 1.1 million tons when completed in 1973, an increase of 150,000 tons a year. The company plans to phase out its 64-year-old Belleville plant with a capacity of 770,000 tons by October 1973. The company also plans to add a new kiln, 15 feet by 17.5 feet in diameter by 490 feet long, with an annual capacity of 500,000 tons, at its St. Constant, Quebec, plant. When completed in 1974 the total capacity will be 1 million tons. Canada Cement Lafarge planned to replace two old kilns at its Exshaw, Alberta, plant with a new kiln which will increase the capacity by 200,000 tons. When completed in 1975 the total annual capacity will be 700,000 tons. The company was also modernizing its Havelock, New Brunswick, plant and will increase the capacity 100,000 tons a year.

Independent Cement Inc. installed a fourth kiln during 1972 that increased the annual capacity of its Joliette, Quebec plant 220,000 tons to a total 880,000 tons. St. Lawrence Cement Co., operating the largest suspension preheater kiln in North America at Clarkson, Ontario, was installing the largest grinding mill in the world, 18 feet in diameter by 72 feet in length. Lake Ontario Cement Ltd. will increase annual capacity at Picton 850,000 tons by the end of 1974. St. Marys Cement Ltd. at Bowmanville planned to increase the annual capacity of its plant 350,000 by yearend 1974 with the installation of a kiln 14 feet by 16 feet in diameter by 480 feet long.

Chile.—Corporación de Fomento de la Producción has obtained a majority share holding in Cemento Cerro Blanco de Polpaico and Fabrica de Cemento El Melon S.A. In December the Soviet Union agreed to assist in building a cement plant in the south.

China, People's Republic of.—The number of small cement plants in the provinces has about doubled since 1960, with about 2,400 reportedly operating in 1972. The combined output of the plants provided more than 40% of the total national production. Following is a brief summary of small cement plants in some provinces or autonomous regions: Fukien—59 plants in 48 out of a total of 66 hsien (counties) and municipalities with total output exceeding 400,000 tons; Yün-nan—about one-third of its counties have small plants; Kan-su–77 plants are located in 52% of the counties; Honan—more than 100 plants were set up mostly by counties; Chiang-Hsi—of the 125 plants in the province, 116 are run by counties and communes; Chiang-Su—93 plants in 57 counties and municipalities accounted for 50% of the total cement output of the province; Shen-hsi—107 plants operated at or above county level and more than 200 commune-operated plants; Che-Chiang—a large number of small plants operated in the majority of the counties and 6 coastal regions; Hsin-Chiang—more than 50 plants were in operation with the output accounting for 53% of the total in the region and another 30 plants were under construction; and Kwang-tung—129 small plants and 12 large plants were operating in 91 out of 107 counties and municipalities in the province. Output of the small plants accounted for 74% of the total. In Nan-Hai County, Fo-Shan region (ti chu), 27 commune-operated kilns with a combined total annual capacity of 8,000 tons were producing cement in addition to the county-operated plants.

Quality of the small plant cement production was reported at or above grade 400, which has a compressive strength about two-thirds that of type I portland cement (ASTM C–150).

Colombia.—Cementos del Caribe S.A. was installing a new kiln at its Baranquilla plant. When completed in late 1973 the daily capacity will be increased by 880 tons a day.

Costa Rica.—Calhidia S.A., a joint venture of Costa Rican and Spanish investors, received government approval for the installation of the country's second cement plant. Located at Patarrá near San Jose, the initial annual capacity will be 132,000 tons. Completion was scheduled for October 1975. Construction was started by Industria Nacional de Cemento S.A. at its Cartago plant to convert from a wet-process to dry-process kiln to raise the annual production capacity to 450,000 tons by the end of 1974.

Cyprus.—Cyprus Cement Co. Ltd. planned to install a new kiln at its Moni plant with a daily capacity of 700 tons. When completed in the spring of 1975 the annual capacity of the plant will be 350,000 tons.

Czechoslovakia.—A plant was under construction in western Slovakia that will have an annual capacity of 770,000 tons of portland cement and 100,000 tons of white and colored cement.

Dahomey.—Société des Ciments du Dahomey operated a clinker-grinding plant at Cotonou with an annual capacity of 200,000 tons. A kiln was under construction at Onigbolo near Pobe with an annual capacity of 300,000 tons.

Denmark.—Aalborg Portland Cement Co. installed a new 22.6 feet in diameter by 774 feet in length dry kiln at its Rørdal plant, and increased the daily capacity by 2,500 tons. The clinker cooler comprises 11 planetary tubes, each 65.6 feet long by 7 feet in diameter.

Dubai.—National Cement Co. Ltd. planned to start construction of a cement plant about 6 miles south of Dubai in 1973. The plant will have an annual capacity of 500,000 tons, the largest in the Persian Gulf, when completed in May 1975.

Egypt, Arab Republic of.—In October tenders were issued for equipment to expand the annual capacity of two cement plants at Torah and Alexandria nearly 1 million tons. In November Soviet Union assistance was secured to build two new plants with a combined annual capacity exceeding 1 million tons at Assyut in Upper Egypt and Helwan near Cairo. When construction of the four plants is completed the country's total capacity will rise to 4.8 million tons. A fifth plant with an annual capacity of 600,000 tons was planned for construction at Alexandria for completion by 1977.

Finland.—Lojo Kalkverk installed a new kiln with an annual capacity of 350,000 tons at its Virkby plant.

France.—On June 5, Ciments de Champagnole S.A. started operation of its new plant at Rochefort-sur-Nenon (Jura) with an annual capacity of 450,000 tons. S.A. des Ciments Vicat began operating a new kiln with a capacity of 300,000 tons.

Germany, West.—Breitenburger Portland-Cement-Fabrik had a new kiln under construction at its Lägerdorf plant with a daily capacity of 3,300 tons. Nordcement A.G. scheduled completion of its new 1-million-ton-a-year Alemannia plant at Höver for spring 1973. Bomke and Bleckmann, Dyckerhoff, Heidelberg, Solnhofer, and Wittekind each had expansion projects under construction with a combined annual capacity of 3.6 million tons.

Greece.—General Cement Co. S.A. started full production with new kiln facilities at its Olympos plant in Volos that increased annual capacity by 850,000 tons to a total of 2 million tons. The company announced plans for a third plant at Méthana, Eastern Pelopónnesus, near the Saronic Gulf, with an initial annual capacity of 1.4 million tons scheduled for 1975. Halyps Cement Co. S.A. was constructing a new kiln at its Skaramanga plant that will increase annual capacity from 460,000 tons to 900,000 tons when completed in 1973.

Hungary.—A cement plant started operation at Beremend near Siklos with an annual capacity of 1 million tons.

India.—Jaipur Udyog Ltd. started operating a plant at Beawar, Ajmer district of Rajasthan, with an initial capacity of 290,000 tons a year to be increased to 580,000 tons in 1973. The Cement Corp. of India Ltd. was constructing a plant at Kurkunta and had plans for two new plants at Bukajan, Assam, and Paonta, Himachal Pradesh, each with an annual capacity of 200,000 tons. A cement plant was reported operating in Cherrapunjee, reputed to be one of the wettest places on earth.

Indonesia.—Cibinong Cement Co. will install a single dry-process kiln with a suspension preheater at Cibinong, 30 miles south of Jakarta. The $31.5 million plant scheduled for completion by yearend 1974 will have an annual capacity of 550,000 tons. The company will construct a $3.5 million power plant to serve the new facility. Yuo Ming Co. Ltd. of Hong Kong, in a joint venture with P. T. Gunung Ngadeg Djaya, plans to build a $20 million cement plant in central Java.

Iraq.—A new plant was planned for construction at Al Fallujah, about 35 miles west of Baghdad, with an annual capacity of 200,000 tons. Another plant to be built by Polish engineers was scheduled for completion in 1974 near Baghdad with an annual capacity of 84,000 tons.

Ireland.—Cement Ltd. started operating a new kiln at Platin, west of Drogheda, with an increased annual capacity of 400,000 tons. Cement Roadstone Ltd. was constructing the country's third and largest cement plant at Platin, which was near completion at yearend.

Israel.—Israel Portland Cement Works "Nesher" Ltd., the country's sole cement producer, purchased a third plant at Bet Shemesh (halfway between Jerusalem and Tel Aviv) that has been closed. The plant will be rehabilitated for operation in May 1973. The company plans to build a fourth plant with an annual capacity of 660,000 tons for operation in 1975. By then the annual production capacity will reach 2.5 million tons. Uri Matissis and Co. planned to build a 400,000-ton-a-year plant in Mizpe Ramon, Negev, about 30 miles south of Beersheba.

Italy.—Increased production costs, government price controls, and a building recession forced seven small cement plants to close. At Guidonia, output of the new Union Cementerie Marchino Emiliane e di Augusta S.p.A. (UNICEM) new dry-process kiln with a suspension preheater has exceeded 4,400 tons of clinker a day with fuel consumption averaging 750 Kcal per kg of clinker (approximately 500,000 B.t.u. a barrel). Cementi Portorecanati S.p.A. started operating its new plant at Castelraimondo, Macerata, with an annual capacity of 440,000 tons. Cementerie di Sardegna S.p.A. was constructing a new plant at Samatzai, with an annual capacity of 440,000 tons when completed in 1973, to replace its Cagliari plant. Cementerie Calabro-Lucane S.p.A. had two plants under construction at Castrovillari, Cosenza, and Matera. When completed in 1973, each plant will have an annual capacity of 440,000 tons.

Japan.—Increased demand and strict pollution control regulations forcing the closure of some kilns were mostly responsible for a cement shortage in the country. Ube Industries, Ltd., installed a new dry-process kiln, reported to be the world's largest, at its Isa plant in Yamaguchi Prefecture. The kiln, 20.3 feet in diameter by 410 feet long, has an annual capacity of nearly 2 million tons, or approximately 230 tons an hour. The suspension preheater is 258 feet high and comprises two lines with four sets of cyclones in each line. The clinker cooler is 14.8 feet by 13.8 feet. A new 200-ton-an-hour vertical grinding mill was installed for the raw materials. Onada Cement Co. Ltd. installed a new kiln equipped with a new Reinforced Suspension Preheater (RSP) system with a daily capacity of 5,500 tons. The company planned to install a 3,000-ton-a-day kiln with the RSP system at its Ofunato plant. Sumitomo Cement Co. Ltd. installed a new kiln at its Tochigi plant with an annual capacity of 720,000 tons and new facilities with a capacity of 1.2 million tons at its Ako Nakamizuo plant in Hyogo-Ken. Nihon Cement Co. Ltd. installed a new kiln with a capacity of 1.2 million tons at its Kamiiso plant in Hokkaido.

Korea, Republic of.—Tong Yang Cement Manufacturing Co. Ltd. planned to more than double the capacity of its Samch'ŭk plant in Kang Wŏn-Do.

Kuwait.—The Kuwait cement factory was dedicated on May 15, 1972. The new plant has an annual capacity of 330,000 tons.

Lebanon.—Romania's Technochin, in a joint venture with a group of Lebanese investors, plans to build Lebanon's fourth cement plant. The plant will have a daily capacity of 880 tons and completion is scheduled for late 1973.

Libya.—Libyan Cement Co. started expanding the capacity of its plant in the

Hawari area near Benghazi. The new plant, started in 1972 with an annual capacity of 220,000 tons, will have an additional capacity of 440,000 tons when completed in 1974. National Cement Co. had under construction an expansion of its plant at Homs to increase the annual capacity from 110,000 tons to 440,000 tons, with completion scheduled for mid 1974.

Malaysia.—Cement Industries of Malaysia Sdn. Berhad was constructing a plant in Perlis with an annual capacity of 400,000 tons. Production was scheduled for October 1974.

Mexico.—By 1972 all cement companies required a minimum of 51% Mexican ownership to comply with a 1970 government decree involving Mexicanization of basic industries. General Portland Cement Co. was negotiating for 49% interest in the Tamuin plant owned by Cementos Anahuac del Golfo S.A. The company had a contract to purchase cement for delivery in the southeastern United States through 1974. Cementos Anáhuac was expanding combined daily production capacity from 5,800 to 8,000 tons. Cementos Guadalajara, S.A. merged with Cementos California S.A. and planned to build a new plant at Culiacán, Sinaloa, with a daily capacity of 1,200 tons. Cementos Veracruz S.A. planned to increase the annual capacity of its Orizaba, Veracruz, plant from 275,000 to 660,000 tons while removing obsolete kilns with a combined 100,000-ton capacity. Completion was scheduled for late 1974. Cementos Atoyac S.A. planned to double the daily capacity of its Puebla plant, from 440 to 880 tons. Cementos de Sinaloa, S.A. was expanding the daily capacity of its Los Hornillos plant from 440 to 1,320 tons. Cementos plant from 440 to 1,320 tons. Cementos Apasco S.A. was constructing a new preheater kiln with a daily capacity of 2,000 tons at its Apaxco plant. The kiln was scheduled for operation in late 1974.

The following companies completed plant expansions in 1972 with the daily capacity increases in parentheses: Cementos Acapulco at Acapulco (330); Cementos Anáhuac at Barrientos (2,000); Cementos Chihuahua at Cuidad Juárez (390); Cementos Maya at Mérida (550); Cementos Mexicanos S.A. at Monterrey (1,300) and at Torreón (550); and Cementos La Cruz Azul at Lagunas (990). Expansions under construction for completion in 1973 were: Cementos Anáhuac at Barrientos (2,200); Cementos La Cruz Azul at Cuidad Cruz Azul (770); and Cementos Tolteca S.A. at Atotonilco (2,200).

Morocco.—The Moroccan and Algerian Governments have signed an agreement for the formation of a jointly-owned company to build and operate a cement plant at Oujda, Morocco, near the Algerian border. The annual capacity of the plant will be 1 million tons.

Mozambique.—On June 30, 1972, Companhia de Cementos de Moçambique S.A.R.L. inaugurated the third kiln at the Nova Maceira plant at Dondo near Beira with an added annual capacity of 330,000 tons, bringing the plant's total to 506,000 tons. The fourth kiln was under construction at the company's Matola plant near Lourenço Marques with an annual capacity of 660,000 tons. Completion was scheduled for late 1977.

Nigeria.—Calabar Cement Co., Ltd. plans to increase the annual capacity of its plant at Calabar from 110,000 to 330,000 tons.

Okinawa.—Ryukyu Cement Co., Ltd. planned to increase the annual capacity of its plant at Yabu 15% from the present 450,000 tons; completion is scheduled for 1973. Niho Cement Co. of Japan acquired a 10% interest in Ryukyu Cement Co., while Kaiser Cement & Gypsum Corp.'s interest was reduced to 46%.

Panamá.—Importation of more than a million sacks of cement was not enough to meet the country's demand. Cemento Atlantico S.A. was installing a new kiln with a preheater at its Colon plant that will increase the annual capacity of the plant from 110,000 to 330,000 tons. Completion was scheduled for 1974.

Paraguay.—Plans were announced to double the capacity of Industria Nacional del Cemento's plant at Puerto Vallemi from 110,000 to 220,000 tons.

Peru.—Cementos Lima S.A. replaced eight old kilns at its Atacongo plant with one kiln equipped with a suspension preheater. The kiln has a daily capacity of 2,700 tons, an increase of 900 tons per day.

Philippines.—Production was only 48% of the 6.6 million tons capacity in 1972. The Development Bank of the Philippines foreclosed on two cement plants. Floro Cement Corp.'s new plant at Lugait, Misamis Oriental and Mindanao Portland Cement Corp.'s plant at Iligan, Lanao did not operate during the year. In 1972 Prime White Cement Corp. became the first company to produce white cement in the Philippines. The annual capacity of the new plant at Asturias, Cebu was 33,000 tons, adequate to meet the country's demand.

Poland.—Two new plants were under construction at Opole and Kielce, each with a daily capacity of 3,500 tons.

Portugal.—Companhia Cimento Tejo was installing two new wet-process kilns at its plant at Alhandra that will increase annual capacity from 858,000 to 1,540,000 tons. Completion was scheduled for 1973. Five Lille-Cail of Paris, France, has a contract to install a dry-process kiln 15 feet in diameter by 230 feet long with a multicyclone preheater for the new plant of Cía. de Cimentos do Norte at Souselas in northern Portugal. When completed early in 1974 the plant will produce 1,760 tons a day of clinker. Cía. Industrial do Cimento do Sul was constructing a new plant at Loulé in the Faro district. When completed in 1973 the annual capacity will be 330,000 tons.

Rwanda.—Plans for a cement plant at Mibirizi were included in a United Nations Industrial Development Organization (UNIDO) report. Also the People's Republic of China was reported to have an agreement to build a cement plant in the Cyangugu area.

Saudi Arabia.—Arabian Cement Co. was doubling the annual capacity of its Jidda plant to 660,000 tons. Completion was scheduled for mid-1974. The Riyadh plant of the Yamama Saudi Cement Co. was brought into operation during 1972.

Senegal.—The capacity of the Société Ouest Africaine des Ciments (SOCOCIM) plant at Rufisque will be increased by 100,000 tons to 400,000 tons a year by the end of 1973.

Somalia.—Somalia Cement Co. planned to build a plant with an annual capacity of 110,000 tons near Berbera with North Korean assistance.

South Africa, Republic of.—Cape Portland Cement Co. Ltd. had under construction the company's largest kiln at its De Hoek plant. The annual capacity will be 500,000 tons.

Spain.—American Cement Corp. signed an agreement to sell its 67% interest in Portland de Mallorca, S.A. to Cementos del Mar S.A. Cementos del Cantábrico started operating its new plant at Aboño, Carreño with an annual capacity of 720,000 tons. Cementos Alba S.A. was constructing a new plant at Jeréz, Cadiz. When completed in 1973, the annual capacity will be 720,000 tons. Portland Valderrivas S.A. had a new plant under construction with an annual capacity of 880,000 tons when completed in 1973.

Sri Lanka (formerly Ceylon).—Ceylon Cement Corp. was installing a second kiln at the Puttalan plant to double the annual capacity to 484,000 tons. When completed in 1973 the country's total capacity will be 787,000 tons a year.

Switzerland.—Cementfabrik Holderbank planned to start construction in 1973 of a new plant at Rekingen, Aargau, with an annual capacity of 700,000 tons. Completion was scheduled for 1975. Société des Chaux et Ciments de la Suisse Romande planned installation of a new third kiln at its Eclépens plant with a daily capacity of 1,500 tons. The kiln will replace two smaller units when completed by mid-1974. Bündner Cementwerke A.G. was installing a new kiln at its Untervaz plant that was expected to be in operation by early 1974.

Taiwan.—Chia Hsin Cement Corp. was doubling the capacity of its Kangshan plant, with completion scheduled for early 1975. Cheng Tai Cement Corp. planned to increase the capacity of its Tsoying plant in Kaohsiung with the addition of a 1,100-ton-a-day dry-process kiln.

Thailand.—The country's cement industry capacity increased from 3,163,000 tons in 1971 to 4,455,000 tons in 1972. Siam Cement Co., Ltd. completed the first full year of production at its new plant in Kaeng Khoi, Saraburi. The plant, with an annual capacity of 825,000 tons, increased the company's total to 3.1 million tons. The company planned to install another kiln equipped with a suspension preheater and having a daily capacity of 2,500 tons at the Kaeng Khoi plant. Siam City Cement Co. started production at its new plant with an annual capacity of 660,000 tons in Saraburi, about 129 kilometers north of Bangkok.

Turkey.—Askale Tesis Müdürlugu was

operating its new plant at Erzurum with an annual capacity of 390,000 tons. The following plants were under construction with completion scheduled for 1974: Bolu Cimento Sanayii A.S. at Bolu with an annual capacity of 550,000 tons; Göltas Cimento A.S. at Isparta (620,000 tons); Mardin Cimento at Mardin (580,000 tons); and Ünye Cimento at Ünye (620,000 tons).

United Kingdom.—Rugby Portland Cement Co. Ltd. was doubling the annual capacity of its plant in Halling, Rochester, Kent, from 400,000 to 800,000 tons. The company was also doubling the capacity of its South Ferriby, Lincolnshire, plant from 390,000 to 779,000 tons. Both plants were scheduled for completion in 1974. Associated Portland Cement Manufacturers Ltd. closed its plants in Greenhithe, Kent; Harbury, Warwickshire; Dunstable, Bedfordshire; and Stone, Kent.

Zaire.—Société des Ciments du Zaire planned to increase the annual capacity of its Lukala plant from 308,000 tons to 660,000 tons. Cimenterie Nationale was constructing a new cement plant at Kimpese with an annual capacity of 330,000 tons. Completion was scheduled for May 1974. An abandoned clinker-grinding plant at Kisangari with a capacity of 198,000 tons a year was being rehabilitated for operation in early 1973.

Zambia.—Chilanga Cement Co. Ltd. was doubling the capacity of its plant at Ndola with the addition of a second dry-process kiln equipped with a suspension preheater and planetary cooler, having a daily capacity of 600 tons. When completed in 1973, the total annual capacity of the plant will be 440,000 tons.

TECHNOLOGY

Several cement producers and equipment manufacturers consider the optimum-size kiln to have a capacity of about 3,300 tons a day. Nevertheless, to fully exploit the economic advantages of mass production some companies were increasing the size of new production units incorporating the latest technology. For many years most of the significant advances in cement production technology were made and tested in Europe and Japan and slowly adopted in the United States. Recent improvements on preheater systems developed in Japan have increased kiln output tremendously and may be the most significant advance in cement technology since the preheater system was introduced.

Shortages of natural gas, fuel oil, and low sulfur coal contributed to a sharp increase in fuel costs for making clinker. Fuel costs amounting to $2.65 a ton of clinker produced in the U.S. were expected to increase and perhaps double in a few years. For this reason more companies were investigating the economics of short kilns equipped with preheaters and, in particular, suspension preheaters. Because of the more effective heat transfer in the preheater system, fuel consumption is greatly reduced in the kiln. In the first 8 months of 1972, 25% of the new kilns sold in the U.S. and Canada were equipped with suspension preheaters, accounting for 35% of the new capacity. A recently installed short kiln with a suspension preheater was producing clinker at nearly 1 million B.t.u. a ton less than long dry kilns operating alongside the new unit. This was about one-half the B.t.u. requirements for long wet kilns.

Development of continuous bypass systems to remove and control alkali content in both traveling grate and suspension type preheaters were significant technological advances that made the preheater kiln more attractive to companies in the United States. More than 450 kilns equipped with preheaters were in operation throughout the world. In 1972, Ube Industries, Ltd., installed a new kiln 20.3 feet in diameter by 410 feet long equipped with a four-stage suspension preheater. This was reported to have the world's largest kiln output with a daily capacity of 5,665 tons.

Other advantages of suspension preheater kilns in addition to lower fuel consumption are shorter material retention time, enabling use of a shorter kiln with a smaller diameter; less heat loss by radiation; and lower capital cost for installation.

Three Japanese firms developed special burners to facilitate calcination of raw materials in the suspension preheater which further increased kiln production capacity by 25% to 50%. Mitsubishi Cement Co., Ltd. received patents for calcining equipment with a fluidized bed called Mitsubishi Fluidized Calcinator (MFC). This unit comprises a separate heat source between the kiln and suspension preheater. Heat consumption of the whole clinker-producing operation including the MFC was 792 Kcal per kg of clinker, about the same as for an ordinary kiln with a suspension preheater. Power consumption using the MFC increased 0.7 kilowatt hours per ton of clinker. Very few kiln upsets occur with the use of MFC, thereby enabling a stabilized operation that increases refractory brick life and, as a result, permits continuous operation for more than 1 year with increased production capacity attained. Using the MFC, old, small kilns can be remodeled to high productivity at a relatively small construction cost.

Onada Cement Co., Ltd., and Kawasaki Heavy Industries, Ltd., jointly developed a two-chamber furnace installed in the suspension preheater structure that greatly increased clinker production capacity and heat efficiency of a kiln. The system, called Reinforced Suspension Preheater (RSP), utilizes a swirl burner and a swirl calciner to increase the decarbonation rate, which is normally 40% in suspension preheaters, to 85% to 90%. The swirling raw meal inside the furnace permits rapid heat transfer. In August 1972, installation of the RSP on the No. 3 kiln at the company's Tahara plant nearly tripled production capacity. Heat consumption for this kiln was estimated to be 760 Kcal per kg of clinker with very small heat loss. To prevent brick problems in large-diameter kilns, the diameter should be limited to 16 to 18 feet. Using the RSP system, this size kiln can produce 6,600 to 8,800 tons of clinker a day. Long continuous kiln operation is possible because of increased refractory brick life. Air pollution control problems are also reduced. The RSP can be used to increase capacity of small, old kilns.

Ishikawajima Harima Heavy Industries Co. and Chichibu Cement Co., Ltd., introduced a flash furnace with special burners to facilitate calcination in the suspension preheater. A kiln, 12.5 feet in diameter by 166 feet long, using the new furnace produced 2,200 tons a day, about twice the amount expected from this size kiln.

Harbison-Walker Refractories patented Trefoils have been in use in numerous kilns for manufacturing lime. Only recently the Trefoil was installed in a wet-process cement plant in Texas and a dry-process kiln in Virginia. The Trefoil is a supplementary heat exchanger near the firing zone of a kiln, built of refractory bricks with shapes arranged to divide the cross-sectional area of the kiln into three equal parts. By dividing the kiln load, more load surface is exposed to direct heat transfer. A fuel savings of 5% to 15% was reported. A slight increase in production occurred because of less dust loss.

To facilitate better heat exchange, one company replaced an old chain system in a kiln with a new chain system and thereby increased the production capacity of the kiln 17% while decreasing fuel consumption 17%.

Where alkali was not a problem some companies were insufflating dust collected in electrostatic precipitators. Dust recovered and pumped to the kiln ranged from 50 to more than 100 tons per day.

European-designed impactor crushers were becoming more widely accepted in the United States, along with the preheater kilns. Increased use of preheater kilns led to new developments in raw material processing. The impactor crusher was amenable to special design in permitting crushing and drying to take place simultaneously utilizing hot exit kiln gases. Raw materials with initial moisture content up to 25% have been effectively processed. Preprocessing in a crusher/dryer may account for a 3% to 15% increase in raw grinding capacity and power consumption reduction by 10% to 15%. An impactor crusher with a capacity of 1,000 tons an hour was installed recently in a western State. Mobile primary crushers were also receiving more consideration.

Roller mills were in competition with ball mills and rodmills for grinding raw materials. Two Loesche roller mills were installed at the Isa plant of the Ube Cement Co. along with the largest kiln in the world. The four-roller mill utilizes hot waste gases from the suspension preheater to dry raw materials from 5% moisture to 0.3%. Each vertical mill has the capacity to grind 230 tons an hour with 90% of the raw meal passing 200 mesh. The mills were driven by 1,500-kw motors each. To sweep the mill a fan with a 1,600-hp motor delivered 250,000 cubic meters of air an hour. Roller mills with a 450-ton-an-hour capacity each were being designed for raw grinding. Because of the limited retention time in ball mills and rodmills, kiln gas is not hot enough to dry raw materials with initial moisture content exceeding 7%. The roller mills dry effectively with kiln exit gas material with 10% to 12% moisture and material with 25% to 28% moisture using an auxiliary heating unit. Depending on the diameter of the rolls, feed size up to 6 inches can be fed to the roller mill. Although the capital cost was about 10% to 15% higher than for a ball mill or rodmill and the installation cost was about the same, the roller mill takes up less space, requires less horsepower, and operates much more quietly.

Lone Star Industries developed a new comminution process for minerals known as the Snyder process. The revolutionary new process utilizes pressure chambers and a fast valve actuator (less than 15 milliseconds) to generate shock phenomena that shatter the rock almost instantaneously, taking advantage of a mineral characteristic of the rock, which is weaker in tension than in compression. The sonic and other shock waves created in the system produce cleavage of the component minerals through internal stress at their natural grain boundaries. This contrasts with the lower efficiency of conventional grinding mills that must overcome the rock's greater compressive strength. Only a prototype installation has been in operation, with a capacity of 10 tons an hour.

A 15.5-foot-diameter by 21-foot-long raw mill powered by a 3,000-hp motor was installed in Arizona. This was the largest diameter-diaphragm ball mill supplied to the cement industry by the manufacturer.

Ball mills continue to be the most important finish-grinding mills. The trend toward larger units persists. Two mills, 16.5 feet in diameter by 54 feet long, with a capacity of 200 tons an hour each, were installed by UNICEM at its plant in Guidonia, Italy. These were gearless, variable-speed motor-driven ball mills rated at 6,000 kw. The cement fines were controlled by automatic on-line permeabilimeters. The world's largest ball mill was under construction at the St. Lawrence Cement Co. plant in Clarkson, Ontario. The 8,700-hp gearless motor, with an 18-foot-diameter by 73-foot-long mill as the rotor, has a stator 32 feet in diameter. The mill was expected to operate in mid-1973.

Many European ball mills use classifying liners, which are reported to increase grinding efficiency from 10% to 25%. The segregating liners produce self-segregation of the ball charge in the second compartment so the larger diameter balls grind the coarser material. This improved grinding efficiency decreases the circulating load, which in turn increases the separator efficiency. High-chromium grinding media used with the segregating liners reduce wear rate and deformation problems. Several domestic producers ordered the new liners for finish-grinding mills.

Sumitomo Cement Co., Ltd., developed a monitoring device for controlling the mill feed rate. Operation was based on measuring the pressure differential of air flow between the inlet and outlet of the mill. Polysius A.G., Neubeckum, West Germany, developed a continuous automatic device for determining grinding fineness. The extremely fine particles of the ground mixture are scanned by a thin needle. A piezoelectric system converts needle oscillations into electric currents that are proportional to the fineness. The method makes it possible to accurately and rapidly monitor, control, and adjust the grinding operation on the basis of the product fineness.

General Portland, Inc. research laboratories developed an expansive cement that does not depend upon sulfo-aluminates to control shrinkage in concrete. The company claims the product has more uniform expansive and stressing properties, works better under hot weather conditions, and has strengths equal to or better than type I cement. Using essentially the same raw materials and requiring only minor plant modification, the new expansive cement was expected to be produced commercially by mid-1973.

Utilizing waste fly ash produced at powerplants, Dundee Cement Co. introduced portland pozzolan (type IP) cement at its plants in Clarksville, Mo., and Dundee, Mich., and Santee Portland Cement Co.

started to intergrind fly ash to produce type IP cement at its Holly Hill, S.C., plant. The Bureau of Mines conducted studies at its Tuscaloosa Metallurgy Research Laboratory in Alabama to investigate use for two solid waste materials, fly ash and calcium silicofluoride. Research led to the development of a regulated set cement comparable to commercial products by using limestone, kaolin, fly ash, and calcium silicofluoride. Strengths equivalent to those of commercial cement were achieved with the same setting times. A report was in preparation.

Table 2.—Finished portland cement produced, shipped, and in stock in the United States,[1] by district [2]

District	Plants active during year		Production [3] (thousand short tons)		Shipments						Stocks at mills December 31 (thousand short tons)	
					1971			1972				
						Value			Value			
	1971	1972	1971	1972	Thousand short tons	Total (thousands)	Average per short ton	Thousand short tons	Total (thousands)	Average per short ton	1971	1972
New York and Maine	10	10	5,154	5,241	5,285	$89,699	$16.97	5,086	$97,391	$19.15	313	464
Eastern Pennsylvania	15	15	5,828	6,028	5,792	105,352	18.19	5,912	114,018	19.29	343	397
Western Pennsylvania	5	5	2,193	2,302	2,057	35,108	17.07	2,302	41,990	18.24	309	225
Maryland and West Virginia	4	4	2,299	2,528	2,310	41,692	18.05	2,487	49,371	19.85	177	186
Ohio	8	8	2,814	2,885	2,897	54,338	18.76	2,968	57,953	19.53	280	356
Michigan	r 10	10	6,015	6,181	6,108	104,665	17.14	5,901	111,410	18.88	620	763
Indiana, Kentucky, Wisconsin	r 9	9	3,252	3,466	3,302	62,301	18.87	3,158	61,493	19.47	242	372
Illinois	3	3	1,513	1,540	1,425	25,975	18.23	1,571	33,124	21.08	127	180
Tennessee	6	6	1,620	1,715	1,713	33,733	19.69	1,695	37,176	21.93	131	130
Virginia, North Carolina, South Carolina	5	5	2,347	2,528	2,444	45,985	18.82	2,469	53,398	21.63	120	182
Georgia	3	3	1,219	1,230	1,214	22,470	18.51	1,260	27,286	21.66	74	66
Florida	4	4	2,186	2,142	2,177	48,970	22.49	2,425	59,773	24.65	107	101
Alabama	7	7	2,298	2,419	2,284	42,281	18.51	2,360	48,577	20.58	117	152
Louisiana and Mississippi	5	5	1,486	1,602	1,558	30,579	19.63	1,707	35,045	20.53	130	89
Minnesota, South Dakota, Nebraska	4	4	1,475	1,555	1,490	28,908	19.40	1,589	34,001	21.40	217	188
Iowa	5	5	2,323	2,491	2,392	47,925	20.04	2,458	49,635	20.19	286	278
Missouri	7	7	4,144	4,329	4,515	77,568	17.18	4,277	80,898	18.91	288	418
Kansas	5	5	1,799	1,986	1,731	29,961	17.31	1,889	35,432	18.76	211	232
Oklahoma and Arkansas	5	5	2,374	2,604	2,364	44,164	18.68	2,560	49,734	19.43	206	249
Texas	18	18	7,138	7,884	7,198	140,206	19.48	7,813	171,642	21.97	467	494
Wyoming, Montana, Idaho	4	4	942	956	937	18,450	19.69	946	20,276	21.43	140	100
Colorado, Arizona, Utah, New Mexico	8	8	2,954	3,145	3,199	69,160	21.62	3,560	79,868	22.43	204	225
Washington	4	4	1,324	1,426	1,149	23,735	20.66	1,239	26,848	21.67	169	169
Oregon and Nevada	3	3	840	831	848	18,048	21.28	854	18,914	22.15	41	44
Northern California	6	5	2,893	2,783	3,109	60,874	19.58	2,855	57,320	20.08	296	267
Southern California	8	8	6,212	6,609	6,008	109,047	18.15	6,231	124,988	20.06	391	306
Hawaii	2	2	373	379	375	10,196	27.19	402	10,732	26.70	50	27
Puerto Rico	3	3	1,992	1,959	2,001	38,413	19.20	1,946	31,756	16.32	26	39
U.S. Total or average [4]	r 176	175	77,007	80,744	77,882	1,459,801	18.74	79,920	1,620,046	20.27	6,082	6,699
Foreign countries [5]	NA	NA	NA	NA	1,123	20,894	18.60	1,512	33,732	22.31	32	10
Total or average [4]	r 176	175	77,007	80,744	79,005	1,480,696	18.74	81,432	1,653,779	20.31	6,114	6,709

r Revised. NA Not available.
1 Includes Puerto Rico.
2 Includes data for six grinding plants: Michigan (2) includes data for Superior, Wisc.; Pennsylvania (2); and one each in Wisconsin, California (1971), and Virginia (1972). Eight white cement facilities: Texas (3); Pennsylvania (2); one each in California, Florida, and Wisconsin; and two plants in Michigan which were phased out in 1972.
3 Includes cement produced from imported clinker.
4 Data may not add to totals shown, because of independent rounding.
5 Cement imported and distributed by domestic producers only. Source of imports withheld to avoid disclosing individual company confidential data.

Table 3.—Portland cement shipped by plants in the United States, by type [1]

(Thousand short tons and thousand dollars)

Type	1971			1972		
	Quantity	Value	Average per ton	Quantity	Value	Average per ton
General use and moderate heat (types I and II)	73,703	1,362,997	$18.49	75,452	1,512,214	$20.04
High-early-strength (type III)	2,691	54,214	20.15	2,827	61,508	21.76
Sulfate-resisting (type V)	545	10,890	19.98	581	11,672	20.09
Oil-well	634	13,220	20.85	671	14,626	21.80
White	414	17,194	41.53	459	20,795	45.31
Portland-slag and portland pozzolan	104	2,068	19.88	438	8,412	19.21
Expansive	211	5,354	25.37	177	5,213	29.45
Miscellaneous [2]	702	14,760	21.03	827	19,341	23.39
Total or average [3]	79,005	1,480,696	18.74	81,432	1,653,779	20.31

[1] Includes Puerto Rico.
[2] Includes type IV, waterproof cements.
[3] Data may not add to totals shown because of independent rounding.

Table 4.—Cement shipments by destination and origin [1]

(Thousand short tons)

Destination	Portland cement [2]		Masonry cement	
	1971	1972	1971	1972
Alabama	1,158	1,261	100	110
Alaska [3]	64	63	W	W
Arizona	1,364	1,544	W	W
Arkansas	783	838	57	65
California, northern	3,207	3,026	(4)	(4)
California, southern	5,323	5,465	(4)	(4)
Colorado	1,239	1,425	35	45
Connecticut [3]	834	874	17	16
Delaware [3]	179	191	8	10
District of Columbia [3]	169	224	28	27
Florida	3,935	5,001	275	377
Georgia	2,172	2,506	218	243
Hawaii	376	402	11	13
Idaho	438	414	2	1
Illinois	3,913	3,606	106	116
Indiana	1,727	1,793	107	115
Iowa	1,615	1,601	25	25
Kansas	983	1,048	20	24
Kentucky	1,083	1,125	97	104
Louisiana	2,179	2,358	60	73
Maine	228	257	11	13
Maryland	1,404	1,432	105	118
Massachusetts [3]	1,347	1,411	47	49
Michigan	3,349	3,231	178	179
Minnesota	1,634	1,602	48	52
Mississippi	789	929	63	72
Missouri	2,026	1,798	36	41
Montana	306	242	2	3
Nebraska	839	956	11	13
Nevada	413	402	(4)	(4)
New Hampshire [3]	181	243	11	13
New Jersey [3]	2,184	2,174	78	80
New Mexico	509	566	13	16
New York, eastern	867	729	37	42
New York, western	853	1,108	35	58
New York, metropolitan [3]	1,525	1,796	49	45
North Carolina	1,608	1,873	232	269
North Dakota [3]	280	312	6	7
Ohio	3,373	3,340	207	230
Oklahoma	1,216	1,398	53	64
Oregon	704	806	(4)	(4)
Pennsylvania, eastern	2,206	2,070	64	73
Pennsylvania, western	1,189	1,203	79	82
Puerto Rico	1,938	1,904	--	--
Rhode Island [3]	203	200	5	6
South Carolina	879	910	148	166
South Dakota	322	319	7	7
Tennessee	1,551	1,608	170	192
Texas	6,159	6,786	154	179
Utah	495	652	1	1
Vermont [3]	107	154	6	6
Virginia	1,887	2,107	199	232
Washington	1,216	1,091	6	7
West Virginia	639	557	33	36
Wisconsin	1,576	1,619	60	65
Wyoming	167	194	2	2
Total United States	78,910	82,744	3,322	3,782
Foreign countries [5]	95	64	70	89
Total shipments	79,005	82,808	3,392	3,871
ORIGIN				
United States [6]	75,881	77,974	3,340	3,779
Puerto Rico	2,001	1,946	--	--
Foreign [7]	1,123	2,888	52	92
Total shipments	79,005	82,808	3,392	3,871

W Withheld to avoid disclosure of individual company confidential data; included with "Foreign countries."
[1] Includes imported cement shipped by domestic producers (1971–1972) and Canadian cement manufacturers and other importers (1972).
[2] Excludes cement used in the manufacture of prepared masonry cement.
[3] Has no cement producing plants.
[4] Less than ½ unit.
[5] Direct shipments by producers to foreign countries, U.S. possessions and territories, and also including States indicated by symbol W.
[6] Includes cement produced from imported clinker by domestic producers.
[7] Includes imported cement distributed by domestic producers (1971–72), Canadian cement manufacturers and other importers (1972). Origin of imports withheld to avoid disclosing individual company confidential data.

Table 5.—Clinker capacity and production in the United States,[1] by district, as of December 31, 1972

District	Active plants [2]: Process used: Wet	Active plants [2]: Process used: Dry	Active plants [2]: Total	Number of kilns	Daily capacity (thousand short tons)	Average number of days for maintenance	Apparent [3] annual capacity (thousand short tons)	Production [4] (thousand short tons)	Percent utilized
New York and Maine	7	3	10	21	17	34	5,621	5,099	90.7
Eastern Pennsylvania	4	9	13	46	19	34	6,291	5,773	91.8
Western Pennsylvania	3	2	5	13	8	38	2,612	2,298	88.0
Maryland and West Virginia	2	2	4	10	8	46	2,550	2,497	97.9
Ohio	5	3	8	22	9	13	3,170	2,846	89.8
Michigan	7	1	8	29	18	33	5,968	5,483	91.9
Indiana, Kentucky, Wisconsin	3	5	8	19	10	21	3,436	3,231	94.0
Illinois	--	3	3	7	4	35	1,319	1,477	112.0
Tennessee	6	--	6	13	6	41	1,944	1,709	87.9
Virginia, North Carolina, South Carolina	3	1	4	11	7	52	2,193	2,069	94.3
Georgia	1	2	3	7	4	50	1,260	1,154	91.6
Florida	4	--	4	12	7	13	2,462	2,089	84.8
Alabama	5	2	7	18	7	21	2,411	2,363	98.0
Louisiana and Mississippi	5	--	5	13	6	58	1,841	1,585	86.1
Minnesota, South Dakota, Nebraska	3	1	4	13	5	24	1,703	1,542	90.5
Iowa	3	2	5	19	8	29	2,689	2,453	91.2
Missouri	5	2	7	12	14	33	4,651	4,317	92.8
Kansas	3	2	5	15	6	5	2,162	1,907	88.2
Oklahoma and Arkansas	3	2	5	11	8	18	2,777	2,632	94.8
Texas	14	4	18	47	24	22	8,232	7,663	93.1
Wyoming, Montana, Idaho	3	1	4	8	3	34	993	952	95.9
Colorado, Arizona, Utah, New Mexico	3	5	8	18	11	16	3,839	3,080	80.2
Washington	3	1	4	7	4	62	1,211	1,108	91.5
Oregon and Nevada	2	1	3	7	3	30	1,005	848	84.4
Northern California	3	2	5	19	10	40	3,248	2,786	85.8
Southern California	2	6	8	30	21	34	6,956	6,234	89.6
Hawaii	1	1	2	3	2	79	571	389	68.1
Puerto Rico	3	--	3	11	7	39	2,284	1,794	78.5
Total or average	106	63	169	461	256	31	85,399	77,378	90.6

[1] Includes Puerto Rico.
[2] Includes white cement manufacturing facilities. Lone Star Industries Inc. ceased clinker production at its Norfolk, Va., plant in April 1972.
[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 6.—Raw materials used in producing portland cement in the United States [1]

(Thousand short tons)

Raw materials	1970	1971	1972
Cement rock	22,824	23,074	23,799
Limestone (including oystershell and aragonite (1972))	83,230	85,857	90,003
Marl	1,669	1,741	2,080
Clay and shale [2]	11,833	11,808	12,158
Blast-furnace slag	853	713	759
Gypsum	3,491	3,750	4,094
Sand and sandstone (including silica and quartz)	2,193	2,226	2,774
Iron materials [3]	777	693	839
Miscellaneous [4]	341	479	414
Total	127,211	130,341	136,920

[1] Includes Puerto Rico.
[2] Includes fuller's earth, diaspore clay, and kaolin.
[3] Includes iron ore, pyrite cinders, and mill scale.
[4] Includes fluorspar, pumicite, calcium chloride, soda ash, borax, staurolite, fly ash, bauxite, diatomite, air-entraining compounds, and grinding aids.

Table 7.—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: Thousand short tons	Clinker produced: Percent of total	Fuel consumed: Coal (thousand short tons)	Fuel consumed: Oil (thousand 42-gallon barrels)	Fuel consumed: Natural gas (thousand cubic feet)
1971:						
Wet	107	45,015	59.8	4,072	8,155	145,888,563
Dry	63	30,216	40.2	3,110	2,599	74,084,672
Total	170	75,231	100.0	7,182	10,754	219,973,235
1972:						
Wet	107	45,846	59.2	4,158	8,898	147,540,429
Dry	63	31,532	40.8	3,181	3,333	75,810,093
Total	170	77,378	100.0	7,339	12,231	223,350,522

[1] Includes Puerto Rico.

Table 8.—Clinker produced in the United States, by kind of fuel [1]

Year and fuel	Clinker produced: Plants	Clinker produced: Thousand short tons	Clinker produced: Percent of total	Fuel consumed: Coal (thousand short tons)	Fuel consumed: Oil (thousand 42-gallon barrels)	Fuel consumed: Natural gas (thousand cubic feet)
1971:						
Coal	40	[2] 15,773	21.0	4,026	XX	XX
Oil	16	[2] 8,549	11.4	XX	8,626	XX
Natural gas	45	[2] 18,679	24.8	XX	XX	111,297,106
Coal and oil	9	4,837	6.4	1,049	95	XX
Coal and natural gas	25	9,199	12.2	967	XX	36,605,834
Oil and natural gas	23	10,360	13.8	XX	1,463	54,393,714
Coal, oil, and natural gas	12	7,834	10.4	1,140	570	17,676,581
Total [3]	170	75,231	100.0	7,182	10,754	219,973,235
1972:						
Coal	36	[2] 14,046	18.2	3,646	XX	XX
Oil	18	[2] 9,206	11.9	XX	9,276	XX
Natural gas	29	[2] 12,098	15.6	XX	XX	75,474,261
Coal and oil	11	6,276	8.1	1,257	484	XX
Coal and natural gas	27	9,585	12.4	1,169	XX	36,182,730
Oil and natural gas	34	17,003	22.0	XX	2,002	90,385,803
Coal, oil, and natural gas	15	9,164	11.8	1,267	469	21,307,728
Total [3]	170	77,378	100.0	7,339	12,231	223,350,522

XX Not applicable.
[1] Includes Puerto Rico.
[2] Average consumption of fuel per ton of clinker produced as follows: 1971—coal, .25525 ton; oil, 1.009 barrels; and natural gas, 5,958 cubic feet. 1972—coal, .25958 ton; oil, 1.008 barrels; and natural gas, 6,239 cubic feet.
[3] Data may not add to totals shown because of independent rounding.

Table 9.—Electric energy used at portland cement plants [1] in the United States [2] by process

Year and process	Electric energy used: Generated at portland cement plants: Active plants	Generated at portland cement plants: Million kilowatt-hours	Purchased: Active plants	Purchased: Million kilowatt-hours	Total: Million kilowatt-hours	Total: Percent	Finished cement produced (thousand short tons)	Average electric energy used per ton of cement produced (kilowatt-hours)
1971:								
Wet	6	174	106	5,536	5,710	56.9	46,088	123.9
Dry	10	677	64	3,643	4,320	43.1	30,919	139.7
Total	16	851	170	9,179	10,030	100.0	77,007	130.2
Percent of total electric energy used	XX	8.5	XX	91.5	100.0	XX	XX	XX
1972:								
Wet	7	204	104	5,693	5,897	55.9	47,878	123.2
Dry	8	646	67	4,009	4,655	44.1	32,866	141.6
Total	15	850	171	9,702	10,552	100.0	80,744	130.7
Percent of total electric energy used	XX	8.1	XX	91.9	100.0	XX	XX	XX

XX Not applicable.
[1] Includes grinding plants and white cement facilities.
[2] Includes Puerto Rico.

Table 10.—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: In bulk	Shipments from plants to terminal: In containers	Shipments to ultimate consumer: From terminal to consumer: In bulk	From terminal to consumer: In containers	From plant to consumer: In bulk	From plant to consumer: In containers	Total shipments
1971:							
Railroad	8,487	262	694	23	10,991	668	12,376
Truck	952	71	18,021	844	41,187	5,272	65,324
Barge and boat	8,429	9	168	--	1,075	6	1,249
Unspecified [2]	--	--	--	--	44	12	56
Total	17,868	342	18,883	867	53,297	5,958	[3] 79,005
1972:							
Railroad	9,020	295	835	213	11,126	714	12,888
Truck	516	60	17,940	848	43,278	5,253	67,319
Barge and boat	8,426	5	312	--	843	--	1,155
Unspecified [2]	--	--	--	--	63	7	70
Total	17,962	360	19,087	1,061	55,310	5,974	[3] 81,432

[1] Includes Puerto Rico.
[2] Includes cement used at plant.
[3] Bulk shipments were 91.4% (72,180 tons); container (bag) shipments were 8.6% (6,825 tons) for 1971. Bulk shipments were 91.4% (74,397 tons); container (bag) shipments were 8.6% (7,035 tons) for 1972.

Table 11.—Cement shipments by type of customer

(Quantities in thousand short tons)

District	Building material dealers		Concrete product manufacturers		Ready-mixed concrete		Highway contractors		Other contractors		Federal, State and other government agencies		Miscellaneous including own use		Total [1]
	Quantity	Percent	Quantity	Percent	Quantity	Percent	Quantity	Percent	Quantity	Percent	Quantity	Percent	Quantity	Percent	
1971															
New York and Maine	313	5.9	693	13.1	3,881	73.4	193	3.7	101	1.9	3	0.1	102	1.9	5,285
Eastern Pennsylvania	1,178	20.3	1,267	21.9	2,936	50.7	361	6.2	5	.1	4	.1	41	.7	5,792
Western Pennsylvania	149	7.2	293	14.3	1,280	62.2	290	14.1	6	.3	--	--	39	1.9	2,057
Maryland and West Virginia	144	6.2	494	21.4	1,518	65.7	77	3.3	41	1.8	13	.6	23	1.0	2,310
Ohio	158	5.5	485	16.7	1,698	58.6	406	14.0	73	2.5	--	--	77	2.7	2,897
Michigan	386	6.3	816	13.4	3,916	64.1	712	11.6	32	.5	60	1.0	186	3.1	6,108
Indiana, Kentucky, Wisconsin	165	5.0	492	14.9	2,259	68.4	305	9.2	44	1.3	--	--	38	1.2	3,302
Illinois	124	8.7	110	7.7	1,079	75.8	86	6.0	19	1.3	3	.2	4	.3	1,425
Tennessee	102	6.0	303	17.7	1,107	64.6	124	7.2	3	.2	34	2.0	40	2.3	1,713
Virginia, North Carolina, South Carolina	202	8.3	365	14.9	1,584	64.8	250	10.2	36	1.5	3	.1	4	.2	2,444
Georgia	89	7.4	188	15.5	666	54.9	206	17.0	51	4.2	11	.9	2	.1	1,214
Florida	393	18.0	377	17.3	1,123	51.6	161	7.4	94	4.3	14	.7	15	.7	2,177
Alabama	211	9.2	315	13.8	1,459	63.9	107	4.7	177	7.8	9	.4	5	.2	2,284
Louisiana and Mississippi	32	2.1	229	14.7	701	45.0	331	21.2	184	11.8	1	.1	80	5.1	1,558
Minnesota, South Dakota, Nebraska	152	10.2	101	6.7	786	52.8	406	27.3	17	1.1	--	--	28	1.9	1,490
Iowa	90	3.7	672	28.1	1,292	54.0	317	13.3	9	.4	8	.3	4	.2	2,392
Missouri	194	4.3	280	6.2	3,299	73.1	642	14.2	55	1.2	11	.3	33	.7	4,515
Kansas	147	8.5	140	8.1	1,223	70.7	114	6.6	28	1.6	1	--	78	4.5	1,731
Oklahoma and Arkansas	162	6.9	210	8.9	1,412	59.8	424	17.9	102	4.3	1	--	52	2.2	2,364
Texas	401	5.5	734	10.2	4,684	65.1	617	8.6	238	3.3	34	.5	490	6.8	7,198
Wyoming, Montana, Idaho	42	4.5	60	6.4	535	57.1	73	7.8	198	21.1	3	.3	27	2.8	937
Colorado, Arizona, Utah, New Mexico	231	7.2	361	11.3	2,244	70.2	161	5.0	131	4.1	7	.2	64	2.0	3,199
Washington	114	9.9	142	12.3	531	46.2	66	5.8	224	19.5	4	.3	69	6.0	1,149
Oregon and Nevada	32	3.8	74	8.7	575	67.9	114	13.4	30	3.6	13	1.5	10	1.1	848
Northern California	179	5.8	245	7.9	2,013	64.8	338	10.9	157	5.0	4	.1	172	5.5	3,109
Southern California	537	8.9	738	12.3	3,987	66.4	497	8.3	215	3.6	13	.2	21	.3	6,008
Hawaii	21	5.7	41	10.9	292	78.0	5	1.3	9	2.4	--	.1	6	1.6	375
Puerto Rico	681	34.0	256	12.8	949	47.4	--	--	76	3.8	36	1.8	3	.2	2,001
Imports	52	4.6	147	13.0	859	76.5	60	5.4	--	--	--	--	6	.5	1,123
Total [1]	6,681	8.5	10,627	13.4	49,890	63.1	7,445	9.4	2,355	3.0	290	.4	1,718	2.2	79,005

See footnotes at end of table.

Table 11.—Cement shipments by type of customer—Continued

(Quantities in thousand short tons)

District	Building material dealers		Concrete product manufacturers		Ready-mixed concrete		Highway contractors		Other contractors		Federal, State and other government agencies		Miscellaneous including own use		Total [1]
	Quantity	Percent	Quantity	Percent	Quantity	Percent	Quantity	Percent	Quantity	Percent	Quantity	Percent	Quantity	Percent	
1972															
New York and Maine	336	6.6	699	13.8	3,830	75.3	102	2.0	42	.8	2	(2)	75	1.5	5,086
Eastern Pennsylvania	620	10.5	1,451	24.5	3,416	57.8	291	4.9	81	1.4	10	.2	43	.7	5,912
Western Pennsylvania	189	8.2	331	14.4	1,443	62.6	236	10.3	52	2.3	--	--	51	2.2	2,302
Maryland and West Virginia	124	5.0	575	23.1	1,652	66.4	65	2.6	49	2.0	12	.5	10	.4	2,487
Ohio	177	6.0	521	17.6	1,847	62.2	336	11.3	24	.8	--	--	63	2.1	2,968
Michigan	415	7.0	916	15.5	3,775	64.0	597	10.1	26	.5	13	.2	159	2.7	5,901
Indiana, Kentucky, Wisconsin	144	4.6	455	14.4	2,091	66.2	410	13.0	30	.9	--	--	28	.9	3,158
Illinois	152	9.7	117	7.5	1,193	76.0	93	5.9	9	.5	4	.2	3	.2	1,571
Tennessee	115	6.8	361	21.3	1,078	63.6	85	5.0	10	.6	22	1.3	24	1.4	1,695
Virginia, North Carolina, South Carolina	189	7.7	422	17.1	1,611	65.2	210	8.5	29	1.2	5	.2	3	.1	2,469
Georgia	87	6.9	167	13.2	764	60.6	166	13.2	32	2.6	5	.4	39	3.1	1,260
Florida	406	16.7	555	22.9	1,201	49.5	155	6.4	80	3.3	14	.6	14	.6	2,425
Alabama	222	9.4	333	14.1	1,484	62.9	76	3.2	232	9.8	9	.4	4	.2	2,360
Louisiana and Mississippi	34	2.0	209	12.3	821	48.1	354	20.7	251	14.7	2	.1	36	2.1	1,707
Minnesota, South Dakota, Nebraska	101	6.3	152	9.6	939	59.1	334	21.0	39	2.5	--	--	24	1.5	1,589
Iowa	81	3.3	389	15.8	1,602	65.2	359	14.6	15	.6	5	.2	7	.3	2,458
Missouri	183	4.3	304	7.1	3,029	70.8	644	15.1	25	.6	9	.2	83	1.9	4,277
Kansas	155	8.2	146	7.7	1,275	67.5	195	10.3	24	1.3	3	.2	91	4.8	1,889
Oklahoma and Arkansas	209	8.2	225	8.8	1,531	59.8	441	17.2	114	4.4	2	.1	38	1.5	2,560
Texas	541	6.9	640	8.2	4,699	60.2	665	8.5	328	4.2	78	1.0	862	11.0	7,813
Wyoming, Montana, Idaho	40	4.2	71	7.5	638	67.5	38	4.0	118	12.5	3	.3	38	4.0	946
Colorado, Arizona, Utah, New Mexico	308	8.7	458	12.9	2,505	70.3	137	3.8	88	2.5	6	.2	58	1.6	3,560
Washington	60	4.8	207	16.7	701	56.6	65	5.2	146	11.8	7	.6	53	4.3	1,239
Oregon and Nevada	41	4.8	44	5.2	629	73.7	94	11.0	38	4.4	--	--	8	.9	854
Northern California	181	6.3	236	8.3	1,920	67.3	204	7.1	175	6.1	2	.1	137	4.8	2,855
Southern California	520	8.3	708	11.4	4,439	71.2	340	5.5	155	2.5	28	.4	41	.7	6,231
Hawaii	20	5.0	53	13.2	314	78.1	5	1.2	6	1.5	--	--	4	1.0	402
Puerto Rico	593	30.5	236	12.1	1,008	51.8	--	--	71	3.6	35	1.8	3	.2	1,946
Imports	137	9.1	251	16.6	974	64.4	123	8.1	21	1.4	3	.2	3	.2	1,512
Total [1]	6,380	7.8	11,232	13.8	52,409	64.4	6,820	8.4	2,310	2.8	279	.3	2,002	2.5	81,432

[1] Data may not add to totals shown because of independent rounding.
[2] Less than 0.1%.

Table 12.—Prepared masonry cement produced and shipped in the United States, by district

District	Plants active during year 1971	Plants active during year 1972	Production (thousand short tons) 1971	Production (thousand short tons) 1972	Shipments from mills 1971 Thousand short tons	1971 Value Total (thousands)	1971 Value Average per ton [1]	Shipments from mills 1972 Thousand short tons	1972 Value Total (thousands)	1972 Value Average per ton [1]
New York and Maine	6	6	115	129	123	$2,966	$24.11	126	$3,004	$23.84
Eastern Pennsylvania	10	10	281	296	271	7,404	27.32	289	8,016	27.74
Western Pennsylvania	5	5	157	162	148	3,843	25.97	162	4,384	27.06
Maryland and West Virginia	3	3	127	151	125	2,685	21.48	145	3,406	23.49
Ohio	5	5	142	160	142	3,811	26.84	161	4,684	29.09
Michigan	4	4	228	259	239	5,872	24.57	250	5,959	23.84
Indiana, Kentucky, Wisconsin	5	5	447	520	457	10,151	22.21	509	12,400	24.36
Illinois	3	3	71	76	73	2,336	32.00	80	2,483	31.04
Tennessee	4	4	196	217	159	3,649	22.95	176	4,104	23.32
Virginia, North Carolina, South Carolina	5	5	325	389	332	9,409	28.34	397	12,122	30.53
Georgia	5	5	198	234	63	1,470	23.33	68	1,569	23.07
Florida					180	4,877	27.09	213	6,901	32.40
Alabama	8	7	347	411	349	8,657	24.81	407	11,221	27.57
Louisiana and Mississippi	4	2	37	36	53	1,237	23.34	49	1,091	22.27
Minnesota, South Dakota, Nebraska	4	4	31	34	32	860	26.88	36	988	27.44
Iowa	3	3	71	68	66	1,719	26.05	66	1,916	29.03
Missouri	6	5	74	85	72	1,629	22.63	80	1,859	23.24
Kansas	5	5	43	54	50	1,232	24.64	59	1,452	24.61
Oklahoma and Arkansas	5	5	100	119	100	2,382	23.82	119	2,796	23.50
Texas	12	12	182	241	169	4,514	26.71	217	5,812	26.78
Wyoming, Montana, Idaho	4	4	5	5	6	155	25.83	7	174	24.86
Colorado, Arizona, Utah, New Mexico	6	6	117	146	115	3,112	27.06	144	3,371	23.41
Washington	3	4	2	7	5	145	29.00	6	170	28.33
Oregon and Nevada	--	--	--	--	(2)	11	26.19	--	--	--
Northern California	--	1	--	--	--	--	--	W	W	W
Southern California	--	1	--	--	--	--	--	W	W	W
Hawaii	2	2	11	13	11	431	39.18	13	384	29.54
U.S. Total or average [3]	117	116	3,309	3,812	3,340	84,555	25.32	3,776	100,269	26.53
Foreign countries [4]	NA	NA	NA	NA	52	1,219	23.44	71	1,845	26.04
Grand total or average	117	116	3,309	3,812	3,392	85,774	25.29	3,848	102,114	26.52

NA Not Available. W Withheld to avoid disclosing individual company confidential data; included with "Foreign countries."

[1] Computed prior to rounding.

[2] Less than ½ unit.

[3] Data may not add to total 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 13.—Average mill value in bulk, of cement in the United States [1]

(Per short ton)

Year	Portland cement	Slag cement	Prepared masonry cement [2]	All classes of cement
1968	$16.80	$20.75	$20.43	[3] $16.97
1969	17.04	20.44	21.22	[3] 17.18
1970	17.69	W	22.68	17.88
1971	18.74	W	25.28	19.01
1972	20.31	W	26.52	20.59

W Withheld to avoid disclosing individual company confidential data.
[1] Includes Puerto Rico.
[2] Includes masonry cements made at portland, natural, and slag cement plants.
[3] Includes slag cement.

Table 14.—U.S. exports of hydraulic cement, by country

(Short tons and thousand dollars)

Country	1970 Quantity	1970 Value	1971 Quantity	1971 Value	1972 Quantity	1972 Value
Australia	5,115	716	1,205	60	282	25
Austria	205	33	309	34	168	25
Bahamas	5,139	192	2,467	96	2,722	181
Belgium-Luxembourg	242	20	917	54	542	28
Bermuda	175	19	682	40	293	25
Brazil	327	12	849	42	528	17
Canada	86,499	2,235	58,152	1,351	57,862	1,729
Chile	583	26	396	46	1,018	66
Costa Rica	996	32	224	6	512	16
Dominican Republic	276	30	227	40	810	34
Ecuador	2,468	103	604	37	1,126	53
France	339	22	447	21	116	15
French West Indies	14,121	130	7,719	71	76	3
Germany, West	458	85	541	112	444	84
Guatemala	96	r 7	208	26	--	--
Honduras	40	9	190	13	357	16
Indonesia	444	15	515	26	86	5
Italy	330	21	242	9	483	32
Jamaica	696	26	591	r 37	409	24
Japan	2,279	309	3,704	299	1,360	246
Leeward and Windward Islands	16,461	171	12,709	130	9,669	100
Mexico	7,110	366	4,001	355	5,036	316
Netherlands Antilles	5,441	70	5,935	64	7,970	81
Nicaragua	2,115	83	626	24	58	6
Norway	781	20	633	23	409	20
Panama	279	r 14	r 19	r 5	100	14
Peru	129	15	124	14	30	1
Philippines	657	30	301	30	174	15
Saudi Arabia	120	17	271	29	402	33
Spain	362	23	52	12	195	20
Sweden	297	31	136	17	352	26
Switzerland	165	34	453	41	932	72
Taiwan	300	25	486	60	204	9
Trinidad and Tobago	80	8	25	8	383	16
Turkey	263	9	169	24	539	15
United Kingdom	378	14	249	22	431	28
Venezuela	239	20	285	15	175	19
Yugoslavia	--	--	125	27	29	15
Other	3,266	219	2,778	143	4,607	282
Total	159,271	5,211	r 109,566	r 3,463	100,889	3,712

r Revised.

Table 15.—U.S. imports for consumption of cement

(Thousand short tons and thousand dollars)

Year	Roman, portland, and other hydraulic cement Quantity	Roman, portland, and other hydraulic cement Value	Hydraulic cement clinker Quantity	Hydraulic cement clinker Value	White nonstaining portland cement Quantity	White nonstaining portland cement Value	Total Quantity	Total Value
1970	2,150	28,596	402	4,320	45	1,259	2,597	34,176
1971	r 2,327	r 35,681	r 728	r 7,610	33	1,057	r 3,088	44,348
1972	3,192	51,115	1,691	19,672	28	970	4,911	71,757

r Revised.

Table 16.—U.S. imports for consumption of hydraulic and clinker cement, by country

(Thousand short tons and thousand dollars)

Country	1971 Quantity	1971 Value	1972 Quantity	1972 Value
Bahamas	774	12,123	955	15,762
Belgium-Luxembourg	21	714	18	670
Canada	1,560	20,610	2,100	30,433
Colombia	--	--	18	200
Denmark	8	215	21	386
France	r 12	r 494	233	2,888
Germany:				
East	--	--	(1)	6
West	r 6	r 563	5	464
Honduras	--	--	20	399
Italy	--	--	(1)	11
Japan	20	244	(1)	15
Mexico	151	1,859	290	3,587
Norway	436	6,093	601	8,488
Panama	--	--	(1)	4
Peru	--	--	4	62
Spain	3	94	144	2,001
Sweden	r 17	r 223	38	360
Taiwan	--	--	(1)	1
Turkey	--	--	25	295
United Kingdom	55	770	428	5,475
Venezuela	5	55	8	111
Yugoslavia	20	291	3	139
Total	r 3,088	44,348	4,911	71,757

r Revised.
1 Less than ½ unit.

Table 17.—U.S. imports for consumption of hydraulic and clinker cement, by customs district and country

(Thousand short tons and thousand dollars)

Customs district and country	1971 Quantity	1971 Value	1972 Quantity	1972 Value
Anchorage:				
Canada	24	471	57	1,183
Japan	(1)	2	(1)	2
Total	24	r 473	57	1,185
Baltimore: France	(2)	(2)	2	24
Boston:				
Belgium-Luxembourg	--	--	(1)	(1)
Canada	20	419	(1)	1
Total	20	r 419	(1)	1
Bridgeport: Norway	16	227	--	--
Buffalo: Canada	437	r 5,068	500	6,919
Charleston:				
Canada	115	1,442	--	--
United Kingdom	--	--	219	2,503
Total	115	1,442	219	2,503
Chicago:				
Canada	--	--	44	704
Spain	--	--	5	209
Total	--	--	49	913
Detroit:				
Canada	300	2,836	300	3,081
Spain	--	--	86	1,189
Sweden	--	--	38	360
Turkey	--	--	14	209
Total	300	2,836	438	4,839
Duluth: Canada	(1)	14	--	--
El Paso: Mexico	7	165	26	499
Galveston:				
Denmark	--	--	12	148
Germany, West	(1)	5	--	--
United Kingdom	7	227	54	914
Total	7	232	66	1,062
Great Falls: Canada	2	49	3	64
Honolulu:				
Denmark	(1)	(1)	--	--
Japan	16	148	1	13
Total	16	148	1	13
Houston:				
Germany, West	(1)	12	--	--
United Kingdom	--	--	48	492
Total	(1)	12	48	492
Laredo: Mexico	(1)	11	(1)	9

See footnotes at end of table.

Table 17.—U.S. imports for consumption of hydraulic and clinker cement, by customs district and country—Continued

(Thousand short tons and thousand dollars)

Customs district and country	1971		1972	
	Quantity	Value	Quantity	Value
Los Angeles:				
Germany, West	(1)	14	(1)	10
Japan	1	17	--	--
Spain	(1)	1	--	--
Taiwan	--	--	(1)	1
United Kingdom	2	55	1	52
Total	3	87	1	63
Miami:				
Bahamas	319	4,796	257	4,147
Belgium-Luxembourg	1	22	1	27
Canada	--	--	55	644
Honduras	--	--	3	87
Mexico	28	376	67	837
Norway	--	--	139	1,389
Peru	--	--	4	62
Turkey	--	--	11	86
United Kingdom	34	289	105	1,474
Total	382	r 5,483	642	8,753
Milwaukee: Canada	(1)	2	71	838
Mobile: United Kingdom	(1)	2	--	--
New Orleans:				
Spain	3	92	--	--
United Kingdom	--	--	1	31
Total	3	r 92	1	31
New York City:				
Canada	2	20	--	--
Denmark	3	36	--	--
France	(1)	3	--	--
Norway	420	5,866	462	7,099
Spain	(1)	1	--	--
Sweden	r 17	r 223	--	--
Yugoslavia	17	176	--	--
Total	r 459	r 6,325	462	7,099
Norfolk:				
Bahamas	134	2,063	172	3,164
France	r 11	r 451	230	2,846
Italy	--	--	(1)	11
Spain	--	--	19	213
United Kingdom	7	86	--	--
Total	r 152	r 2,600	421	6,234
Ogdensburg:				
Canada	226	3,917	298	5,220
Mexico	(1)	1	--	--
Panama	--	--	(1)	4
Total	226	r 3,918	298	5,224
Pembina: Canada	33	697	99	1,981
Philadelphia:				
Canada	--	--	40	540
Germany:				
East	--	--	(1)	6
West	6	515	5	454
Spain	--	--	21	174
United Kingdom	(1)	4	--	--
Yugoslavia	3	115	3	139
Total	9	634	69	1,313
Portland, Maine: Canada	8	196	63	821
Portland, Oreg.:				
Canada	(1)	2	--	--
Japan	(1)	1	--	--
United Kingdom	(1)	12	--	--
Total	(1)	r 15	--	--
Providence: Canada	17	329	--	--
St. Albans:				
Canada	85	1,862	112	2,639
United Kingdom	(1)	(1)	--	--
Total	85	1,862	112	2,639
San Juan:				
Belgium-Luxembourg	18	648	13	538
Colombia	--	--	18	200
Denmark	5	179	5	183
France	(1)	18	(1)	18
Germany, West	(1)	12	--	--
Honduras	--	--	3	41
Japan	3	71	--	--
Spain	--	--	13	216
Venezuela	5	55	8	111
Total	31	r 983	60	1,307
Savannah:				
France	1	22	--	--
Germany, West	(1)	5	--	--
United Kingdom	(1)	6	--	--
Total	1	r 33	--	--
Seattle:				
Canada	291	3,286	361	4,533
Japan	(1)	5	--	--
United Kingdom	1	40	(1)	9
Total	292	r 3,331	361	4,542
Tampa:				
Bahamas	321	5,264	526	8,451
Belgium-Luxembourg	2	44	4	105
Canada	--	--	97	1,265
Denmark	--	--	4	55
Honduras	--	--	14	271
Mexico	116	1,306	197	2,242
Total	439	6,614	842	12,389
Wilmington, N.C.: United Kingdom	4	49	--	--
Grand total	r 3,088	44,348	4,911	71,757

r Revised.
1 Less than ½ unit.
2 Revised to none.

Table 18.—Statistical summary of cement in the United States, 1818–1972 [1] [2]

Year	Production [3]: Clinker	Production: Cement: Portland	Production: Cement: Natural, masonry, and pozzolan [9] [14] [10] [11] [12]	Production: Cement: Total all cement [13]	Shipments from mills [3]: Portland [6] [7] [8]: Quantity	Portland: Value: Thousand dollars	Portland: Value: Average per ton	Natural, masonry, pozzolan [9] [10] [11] [12]: Quantity	Natural, masonry, pozzolan: Value: Thousand dollars	Natural, masonry, pozzolan: Value: Average per ton	Imports [3] [4]	Exports [3] [4]	Number of active production plants: Portland	Number of active production plants: Natural, slag and pozzolan	Number of active production plants: Masonry [10] [11]	Portland cement manufacturing capacity [5]: Quantity [3]	Portland cement manufacturing capacity: Percent used [15]
1818–29	NA	--	56	56	--	--	--	56	246	$4.39	--	--	--	NA	--	--	--
1830–39	NA	--	188	188	--	--	--	188	850	4.52	--	--	--	NA	--	--	--
1840–49	NA	--	799	799	--	--	--	799	3,612	4.52	--	--	--	NA	--	--	--
1850–59	NA	--	2,068	2,068	--	--	--	2,068	9,350	4.52	4	--	--	NA	--	--	--
1860–69	NA	--	3,087	3,087	--	--	--	3,087	13,957	4.52	4	--	--	NA	--	--	--
1870–79	NA	15	4,136	4,151	15	246	$16.40	4,136	18,700	4.52	156	--	NA	NA	NA	NA	NA
1880	NA	8	382	390	8	126	15.75	382	1,727	4.52	35	--	NA	NA	NA	NA	NA
1881	NA	11	459	470	11	150	13.64	459	2,379	5.18	42	--	NA	NA	NA	NA	NA
1882	NA	16	595	611	16	191	11.94	595	3,482	5.85	70	--	NA	NA	NA	NA	NA
1883	NA	17	771	788	17	194	11.41	771	4,100	5.32	86	--	NA	NA	NA	NA	NA
1884	NA	19	733	752	19	210	11.05	733	3,510	4.79	110	--	NA	NA	NA	NA	NA
1885	NA	28	752	780	28	292	10.43	752	3,200	4.26	104	--	NA	NA	NA	NA	NA
1886	NA	28	818	846	28	292	10.43	818	3,698	4.52	172	--	NA	NA	NA	NA	NA
1887	NA	47	1,258	1,305	47	488	10.38	1,258	5,187	4.12	285	--	NA	NA	NA	NA	NA
1888	NA	47	1,176	1,223	47	488	10.38	1,176	4,534	3.86	345	--	NA	NA	NA	NA	NA
1889	NA	56	1,228	1,284	56	500	8.93	1,228	4,703	3.83	327	--	18	63	NA	NA	NA
1890	NA	63	1,399	1,462	63	704	11.17	1,399	3,823	2.73	365	--	17	67	NA	NA	NA
1891	NA	85	1,460	1,545	85	968	11.39	1,460	3,671	2.51	562	--	17	67	NA	NA	NA
1892	NA	103	1,544	1,647	103	1,153	11.19	1,544	3,991	2.58	459	--	16	68	NA	NA	NA
1893	NA	111	1,393	1,504	111	1,158	10.43	1,393	3,252	2.33	503	--	19	68	NA	NA	NA
1894	NA	150	1,422	1,572	150	1,383	9.20	1,422	3,636	2.56	496	--	24	68	NA	NA	NA
1895	NA	186	1,455	1,641	186	1,587	8.53	1,455	3,895	2.68	563	--	22	64	NA	NA	NA
1896	NA	290	1,501	1,791	290	2,424	8.36	1,501	4,061	2.71	562	--	26	70	NA	NA	NA
1897	NA	503	1,572	2,075	503	4,316	8.58	1,572	3,910	2.49	393	--	29	72	NA	NA	NA
1898	NA	694	1,627	2,321	694	5,971	8.60	1,627	4,087	2.51	217	--	31	79	NA	NA	NA
1899	NA	1,062	1,918	2,980	1,063	8,074	7.60	1,918	5,083	2.65	396	--	36	78	NA	NA	NA
1900	NA	1,595	1,645	3,240	1,595	9,281	5.82	1,645	4,003	2.43	449	19	50	64	NA	NA	NA
1901	NA	2,390	1,383	3,773	2,390	12,532	5.24	1,383	3,254	2.35	176	70	56	60	NA	NA	NA
1902	NA	3,239	1,602	4,841	3,239	20,864	6.44	1,602	4,502	2.81	369	64	65	69	NA	NA	NA
1903	NA	4,200	1,421	5,621	4,200	27,713	6.60	1,421	4,218	2.97	423	54	76	73	NA	NA	NA
1904	NA	4,983	972	5,955	4,983	23,355	4.69	972	2,677	2.75	182	146	81	69	NA	NA	NA
1905	NA	6,626	913	7,539	6,626	33,246	5.02	913	2,686	2.94	169	169	89	67	NA	NA	NA
1906	NA	8,735	853	9,588	8,735	52,466	6.01	853	2,836	3.32	427	110	84	64	NA	NA	NA
1907	NA	9,172	648	9,820	9,172	53,993	5.89	648	1,911	2.95	382	169	94	59	NA	NA	NA
1908	NA	9,602	346	9,948	9,602	43,548	4.54	346	930	2.69	158	159	98	29	NA	11,280	85.1
1909	NA	12,218	319	12,537	12,218	52,858	4.33	319	752	2.36	83	199	108	26	NA	17,578	69.5
1910	NA	14,391	232	14,624	14,391	68,206	4.74	232	546	2.35	58	465	111	23	NA	18,362	78.4
1911	NA	14,763	192	14,955	14,763	66,249	4.49	192	456	2.38	31	589	115	19	NA	21,150	69.8
1912	NA	15,498	172	15,670	15,982	69,110	4.32	172	445	2.59	13	793	110	19	NA	20,680	74.9
1913	NA	17,314	160	17,474	16,673	89,107	5.34	160	444	2.78	16	557	113	17	NA	21,620	80.1

See footnotes at end of table.

Table 18.—Statistical summary of cement in the United States, 1818–1972 [1] [2]—Continued

Year	Production [3]: Clinker	Production [3]: Cement: Portland	Production [3]: Cement: Natural, masonry, and pozzolan [9] [14] [10] [11] [12]	Production [3]: Cement: Total all cement [13]	Shipments from mills [3]: Portland [6] [7] [8]: Quantity	Shipments from mills [3]: Portland [6] [7] [8]: Value: Thousand dollars	Shipments from mills [3]: Portland [6] [7] [8]: Value: Average per ton	Shipments from mills [3]: Natural, masonry, pozzolan [9] [10] [11] [12]: Quantity	Shipments from mills [3]: Natural, masonry, pozzolan [9] [10] [11] [12]: Value: Thousand dollars	Shipments from mills [3]: Natural, masonry, pozzolan [9] [10] [11] [12]: Value: Average per ton	Imports [3] [4]	Exports [3] [4]	Number of active production plants: Portland	Number of active production plants: Natural, slag and pozzolan	Number of active production plants: Masonry [10] [11]	Portland cement manufacturing capacity [5]: Quantity [3]	Portland cement manufacturing capacity [5]: Percent used [15]
1914	NA	16,587	154	16,741	16,250	80,118	$4.93	154	415	$2.69	23	402	110	16	NA	21,620	76.7
1915	NA	18,152	149	16,301	16,336	74,757	4.58	149	398	2.67	8	482	106	15	NA	24,402	66.2
1916	NA	17,206	158	17,364	17,776	104,258	5.87	158	431	2.73	(16)	482	113	13	NA	25,132	68.5
1917	NA	17,449	120	17,569	17,052	122,775	7.20	120	435	3.63	(16)	486	117	10	NA	25,709	67.9
1918	NA	13,363	81	13,444	13,332	113,316	8.50	81	401	4.95	(16)	423	114	9	NA	25,669	51.7
1919	NA	15,188	99	15,227	16,095	146,735	9.12	99	584	5.90	2	463	111	8	NA	25,209	60.2
1920	NA	18,804	144	18,948	18,107	194,439	10.74	144	1,151	7.99	99	561	117	9	NA	27,523	68.3
1921	NA	18,582	101	18,683	17,955	180,778	10.07	101	897	8.88	23	222	115	9	NA	27,138	68.5
1922	NA	21,580	167	21,747	22,128	207,170	9.36	167	1,294	7.75	67	212	118	9	NA	27,486	78.5
1923	NA	25,842	239	26,081	25,551	257,684	10.09	239	1,947	8.15	332	188	126	10	NA	30,429	84.9
1924	NA	28,079	267	28,346	27,457	264,047	9.82	267	2,007	7.52	381	165	132	10	NA	32,919	85.3
1925	30,098	30,392	325	30,717	29,571	278,524	9.42	329	2,552	7.76	589	192	138	10	NA	36,389	83.5
1926	30,731	30,932	396	31,328	30,491	277,965	9.12	382	2,820	7.38	610	183	140	11	NA	40,476	76.4
1927	31,920	32,563	399	32,962	32,311	278,855	8.63	406	2,881	7.10	388	154	153	11	NA	42,691	76.3
1928	32,663	33,144	415	33,559	33,057	275,973	8.35	416	2,910	7.00	433	155	156	11	NA	45,816	72.3
1929	31,770	32,081	415	32,496	31,935	252,154	7.90	406	2,951	7.27	328	166	163	11	NA	48,676	65.9
1930	30,266	30,305	337	30,642	29,903	228,780	7.65	336	2,470	7.35	185	142	163	11	NA	50,768	59.7
1931	22,901	23,581	233	23,814	23,904	140,960	5.90	231	1,620	7.01	88	81	160	12	NA	51,108	46.1
1932	14,101	14,427	86	14,513	15,198	82,022	5.40	99	696	7.03	88	70	160	15	NA	51,006	28.3
1933	11,837	11,933	98	12,031	12,085	85,584	7.08	90	645	7.17	90	128	152	13	NA	50,645	23.6
1934	14,618	14,617	126	14,743	14,269	116,921	8.19	127	961	7.57	50	106	150	11	NA	49,389	29.6
1935	14,161	14,427	189	14,616	14,144	113,372	8.02	190	1,438	7.57	116	78	150	13	NA	49,240	29.3
1936	21,079	21,178	342	21,520	21,216	170,415	8.03	331	2,362	7.14	312	63	149	12	NA	48,035	44.1
1937	21,966	21,841	357	22,198	21,395	168,835	7.89	352	2,579	7.33	339	71	150	12	NA	47,982	45.5
1938	19,574	19,807	342	20,149	19,989	153,977	7.70	351	2,726	7.77	325	105	151	12	NA	48,071	41.2
1939	22,865	22,985	459	23,444	23,058	180,893	7.85	452	3,362	7.44	360	215	150	12	NA	48,207	47.7
1940	24,467	24,481	477	24,958	24,506	190,078	7.76	473	3,387	7.16	101	314	152	12	NA	47,779	51.2
1941	30,762	30,638	541	31,379	31,479	246,622	7.83	550	3,968	7.21	9	480	155	11	NA	46,503	66.3
1942	34,078	34,363	481	34,844	34,837	283,237	8.13	472	3,668	7.77	(16)	207	155	10	NA	46,784	73.5
1943	25,510	25,084	344	25,428	23,995	200,103	8.34	347	2,357	6.79	3	326	153	9	NA	45,582	55.0
1944	17,016	17,090	234	17,324	17,723	150,358	8.48	248	1,639	6.61	(16)	759	151	9	NA	45,220	37.8
1945	19,308	19,327	279	19,606	19,995	173,337	8.67	278	2,094	7.53	(16)	1,217	145	9	NA	45,427	42.5
1946	31,044	30,844	465	31,309	31,879	292,396	9.17	476	4,155	8.73	1	971	153	9	NA	45,425	67.9
1947	35,269	35,066	555	35,621	35,248	356,214	10.11	550	5,764	10.48	1	1,273	150	9	NA	46,832	74.9
1948	39,018	38,624	647	39,271	38,409	445,678	11.60	634	7,734	12.20	53	1,113	150	9	NA	47,803	80.8
1949	39,803	39,429	599	40,028	38,743	473,177	12.21	608	8,006	13.17	21	858	150	9	NA	48,682	81.0
1950	42,636	42,493	798	43,291	42,818	535,321	12.50	793	10,630	13.40	265	455	150	9	NA	50,435	84.3
1951	46,695	46,252	648	46,900	45,337	613,170	13.52	653	9,833	15.06	173	551	155	8	NA	52,928	87.4
1952	47,150	46,860	640	47,500	47,257	638,512	13.51	648	8,752	13.51	90	597	156	8	NA	53,395	87.8
1953	49,831	49,666	656	50,322	49,045	697,263	14.22	650	10,341	15.91	73	480	156	8	NA	54,858	90.5
1954	51,123	51,202	659	57,861	51,676	759,862	14.70	660	13,215	20.02	85	349	157	6	NA	56,029	91.4

1955	56,320	55,921	3,282	59,203	55,040	837,526	15.22	3,286	59,362	18.07	981	337	157	6	119	59,276	94.3
1956	60,147	59,490	3,202	62,692	58,031	940,020	16.20	3,191	63,278	19.83	838	372	160	5	122	65,695	90.6
1957	57,214	56,103	2,882	58,985	54,463	921,959	16.93	2,828	56,772	20.07	832	250	164	5	125	71,513	78.5
1958	58,808	58,556	2,798	61,354	57,729	997,701	17.28	2,809	56,146	19.99	637	120	168	4	132	75,724	77.3
1959	64,053	63,749	3,129	66,878	63,065	1,099,244	17.43	3,124	62,605	20.04	990	52	172	4	134	79,034	80.7
1960	61,011	59,974	2,843	62,817	58,711	1,045,246	17.80	2,781	58,434	21.01	772	35	176	4	140	81,393	73.7
1961	60,801	60,933	2,729	63,662	60,301	1,065,778	17.67	2,749	56,705	20.63	681	54	175	4	143	83,288	73.2
1962	63,300	63,260	2,903	66,163	62,383	1,090,389	17.48	2,875	59,016	20.53	1,059	71	178	4	144	88,167	71.8
1963	66,598	66,278	2,982	69,260	65,660	1,117,974	17.03	3,006	61,006	20.29	758	86	181	4	143	89,766	73.8
1964	69,968	69,303	3,150	72,453	68,865	1,168,987	16.98	3,189	64,362	20.18	683	134	181	4	138	90,168	76.9
1965	70,538	69,827	3,276	73,103	70,328	1,177,863	16.75	3,309	67,006	20.25	1,035	141	181	3	134	90,698	77.0
1966	73,245	72,311	3,222	75,533	71,570	1,187,261	16.59	3,152	63,822	20.25	1,328	201	184	3	134	93,092	77.7
1967	71,172	69,447	3,092	72,539	70,315	1,175,605	16.72	3,056	62,528	20.46	1,112	184	188	2	134	95,683	72.6
1968	74,828	74,243	3,264	77,507	74,720	1,255,519	16.80	3,260	66,591	20.43	1,370	177	183	2	126	95,703	77.6
1969	75,628	75,125	3,250	78,375	77,047	1,312,520	17.04	3,272	69,433	21.22	1,821	111	181	2	122	95,370	78.7
1970	73,990	73,168	2,948	76,116	73,407	1,298,233	17.69	2,978	67,537	22.68	2,597	159	181	2	120	83,675	88.4
1971	75,231	77,007	3,309	80,317	79,005	1,480,696	18.74	3,392	85,774	25.29	3,088	125	176	2	117	85,791	87.7
1972	77,378	80,744	3,812	84,556	81,432	1,653,781	20.31	3,850	102,115	26.52	4,911	101	175	1	116	85,399	90.6

NA Not available.
[1] Source: 1818–1923 U.S. Geological Survey; 1924–1972 U.S. Bureau of Mines. Includes Puerto Rico (1939–1972); Hawaii (1945–1946) (1960–1972).
[2] The data for 1890 and previous years were estimates made at the close of each year and are believed to be substantially correct. Since 1890 the data are based on returns from all producers.
[3] Quantity in units of thousand short tons.
[4] Data prior to 1955 not comparable due to changes in tabulating procedures by the Department of Commerce.
[5] Capacity based on production of finished portland cement (1908–1969); clinker (1970–1972). Clinker capacity calculated on individual company data; (365 days, minus average days for maintenance, times the reported 24 hour kiln capacity).
[6] Data up to and including 1911 are for production. Shipment data not collected before 1912.
[7] Does not include portland cement used in making masonry cement (1955–1972).
[8] Includes cement imported by domestic producers (1966–1972).
[9] Separate data for natural and pozzolan cements are available for the years 1896–1915. Pozzolan cement not included prior to 1896.
[10] The term "Masonry Cement" was first introduced in 1922 and data were included with natural cements.
[11] Separate production and shipment data for masonry cement were collected for the first time in 1955. These data include masonry cement from all domestic portland, natural, and slag cement manufacturers.
[12] Excludes natural and pozzolan cement (1970–1972).
[13] Data may not add to totals shown because of independent rounding.
[14] Production data not collected before 1925. Data for prior years represent shipments.
[15] Calculated prior to rounding.
[16] Less than ½ unit.

Table 19.—Hydraulic Cement: World production by country

(Thousand short tons) [1]

Country	1970	1971	1972 p
North America:			
Bahamas	919	917	1,087
Canada (sold or used by producers)	7,945	9,066	10,010
Costa Rica	206	235	288
Cuba	818	e 830	e 830
Dominican Republic	543	657	746
El Salvador	180	205	240
Guatemala	247	250	291
Haiti	68	79	89
Honduras	168	179	214
Jamaica	487	467	460
Mexico	7,915	8,115	9,482
Nicaragua	140	128	130
Panama	269	310	325
Trinidad and Tobago	299	282	316
United States (including Puerto Rico)	74,619	81,223	83,697
South America:			
Argentina	5,228	6,099	6,002
Bolivia	128	141	166
Brazil	9,923	10,806	12,545
Chile	2,250	1,508	1,548
Colombia	3,082	3,139	3,188
Ecuador	365	407	385
Paraguay	97	67	79
Peru	1,248	1,595	1,793
Uruguay	549	504	513
Venezuela	2,921	3,086	3,287
Europe:			
Albania e	400	400	400
Austria	5,298	6,053	6,994
Belgium	7,417	7,640	7,819
Bulgaria	4,043	4,273	4,312
Czechoslovakia	8,159	8,770	8,863
Denmark	2,870	3,013	e 3,030
Finland	2,066	1,996	2,187
France	31,978	31,910	33,387
Germany, East	8,804	9,340	e 9,370
Germany, West	42,246	45,209	47,559
Greece	5,344	6,106	6,614
Hungary	3,055	2,989	3,267
Iceland	94	110	143
Ireland	947	1,657	e 1,650
Italy	36,460	35,046	36,879
Luxembourg	270	289	341
Netherlands	4,222	4,459	4,435
Norway	2,876	3,000	2,919
Poland	13,426	14,420	15,417
Portugal	2,571	2,709	3,081
Romania	8,958	9,395	10,154
Spain (including Canary Islands)	18,411	18,732	21,429
Sweden	4,490	4,217	4,114
Switzerland	5,288	5,754	6,297
U.S.S.R.	104,993	110,557	114,684
United Kingdom	18,802	19,727	19,894
Yugoslavia	4,849	5,461	6,338
Africa:			
Algeria	1,019	1,063	e 1,060
Angola	496	584	e 680
Cameroon	33	155	187
Cape Verde Islands	19	11	e 11
Egypt, Arab Republic of	4,061	4,322	e 4,080
Ethiopia	200	233	207
Ghana	487	585	457
Ivory Coast	441	551	e 550
Kenya	873	875	e 990
Liberia	100	100	e 100
Libya	105	79	e 90
Malagasy Republic	84	85	71
Malawi	76	69	80
Morocco	1,549	1,626	1,700
Mozambique	434	464	516
Niger	33	33	39
Nigeria	647	721	1,238
Rhodesia, Southern	524	616	e 660
Senegal	266	266	370
Sierre Leone	33	--	--
South Africa, Republic of	6,339	6,455	6,737
Sudan	172	186	175
Tanzania	184	196	261

See footnotes at end of table.

Table 19.—Hydraulic Cement: World production by country—Continued

(Thousand short tons) [1]

Country	1970	1971	1972 p
Africa—Continued			
Tunisia	603	644	693
Uganda	208	223	183
Zaire (formerly Congo-Kinshasa)	462	502	e 510
Zambia	197	519	535
Asia:			
Afghanistan [2]	104	e 100	e 100
Burma	184	217	204
China, People's Republic of e	11,000	13,225	15,400
Cyprus	293	334	466
Hong Kong	474	564	456
India	14,929	16,418	17,306
Indonesia	610	603	e 610
Iran [2]	2,838	3,142	e 3,190
Iraq e	1,500	1,500	1,500
Israel	1,526	1,549	e 1,600
Japan	63,040	65,547	66,841
Jordan	417	462	441
Khmer Republic (formerly Cambodia)	42	65	109
Korea, North	4,420	e 5,290	e 5,840
Korea, Republic of	6,418	7,575	7,252
Lebanon	1,476	1,652	1,792
Malaysia	1,135	1,208	1,168
Mongolia	106	105	e 105
Pakistan	2,834	2,889	2,970
Philippines	2,697	3,102	3,200
Qatar e	280	280	280
Ryukyu Islands e	280	280	280
Saudi Arabia	744	775	1,023
Singapore	800	676	1,112
Sri Lanka	359	425	422
Syrian Arab Republic	1,063	1,002	1,164
Taiwan	4,745	5,559	6,272
Thailand	2,896	3,063	3,739
Turkey	7,024	8,320	9,286
Vietnam, North e	550	550	280
Vietnam, South	315	290	259
Oceania:			
Australia	4,971	5,164	5,441
Fiji Islands	65	86	98
New Zealand	914	907	992
Total	r 629,645	r 667,614	702,666

e Estimate. p Preliminary. r Revised.

[1] Because this table contains data in thousand short tons rather than thousand 376-pound barrels (as in previous editions of this chapter), revisions have not been individually indicated in the 1970 column.

[2] Year beginning March 21 of that stated.

Chromium

By John L. Morning [1]

Technologic change in the manufacture of stainless steel during the past several years brought about increasing use of lower cost high-carbon ferrochromium in place of higher cost low-carbon ferrochromium. Although the domestic chromium alloy producers maintained their production pace of the previous year, increasing demand for chromium alloys was met by imports, which rose to a record high of 141,000 tons.

Table 1.—Salient chromite statistics
(Thousand short tons)

	1968	1969	1970	1971	1972
United States:					
Exports	13	49	41	35	20
Reexports	126	150	73	145	57
Imports for consumption	1,084	1,106	1,405	1,299	1,061
Consumption	1,316	1,411	1,403	1,093	1,140
Stocks Dec. 31: Consumer	912	675	733	1,019	857
World: Production	5,444	5,865	6,672	6,908	6,841

Legislation and Government Programs.—An amendment to Public Law 92–156 (section 503) allowed the importation of strategic and critical materials from Southern Rhodesia in 1972, and the Department of Treasury published regulations removing controls on these materials.[2] Various congressional efforts were made during the year to nullify section 503, but both the House and Senate rejected plans to reinstall the embargo. A Federal suit by some congressional members to reinstate the embargo was rejected by the court.

Government chromium stockpile material inventories and objectives are shown in table 2. Included in the inventories is material sold but unshipped. This includes chemical-grade chromite, 341,680 tons; metallurgical-grade chromite, 116,906 tons; and refractory-grade chromite, 6,772 tons.

General Services Administration (GSA) under various disposal programs offered for sale all three grades of chromite either by competitive bidding or by negotiated sales. Sales were as follows: Chemical-grade chromite, 1,796 tons, and refractory-grade

[1] Supervisory physical scientist, Division of Ferrous Metals.
[2] Federal Register. V. 37, No. 16, Jan. 25, 1972.

Table 2.—U.S. Government chromium stockpile material inventories and objectives
(Thousand short tons)

	Objective	Inventory by program, Dec. 31, 1972			
		National stockpile	Defense Production Act	Supplemental stockpile	Total
Chromite, chemical-grade	250	544	--	366	910
Chromite, refractory-grade	368	991	--	178	1,169
Chromite, metallurgical-grade	2,911	332	901	323	1,556
Ferrochromium, high-carbon	71	126	--	277	403
Ferrochromium, low-carbon	--	128	--	191	319
Ferrochromium-silicon	--	26	--	33	59
Chromium metal	4	1	--	7	8

chromite, 13,618 tons. Actual deliveries of chromite from government stockpiles from current or prior sales contracts were: Chemical-grade, 116,128 tons; metallurgical-grade, 53,366 tons; and refractory-grade, 14,416 tons.

A 1964 finding that chromic acid from Australia was sold at less than fair value within the meaning of the Antidumping Act, 1921, as amended, was revoked in 1972 by the Department of Treasury.[3]

DOMESTIC 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 and Smelting Corp	Woodstock, Tenn.
Foote Mineral Co	Vancoram, Ohio Graham, W.Va.
Interlake Inc	Beverly, Ohio
Ohio Ferro-Alloys Corp	Brilliant, Ohio
Shieldalloy Corp	Newfield, N.J.
Union Carbide Corp	Niagara Falls, N.Y. Marietta, Ohio
Refractory industry:	
The Babcock & Wilcox Co	Augusta, Ga.
Basic, Inc	Maple Grove, Ohio
Corhart Refractories Co., Inc	Buckhannon, W.Va. Louisville, Ky.
E. J. Lavino & Co. (Div. of IMC)	Newark, Calif. Plymouth Meeting, Pa.
General Refractories Co	Baltimore, Md. Lehi, Utah
Harbison-Walker Refractories Co. (Div. of Dresser Industries, Inc.)	Hammond, Ind. Baltimore, Md.
Kaiser Aluminum & Chemical Corp	Moss Landing, Calif. Columbiana, Ohio
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. Kearny, N.J.
PPG Industries, Inc	Corpus Christi, Tex.

Foote Mineral Co. announced at yearend that it would stop ferrochromium production at its Vancoram, Ohio, plant. Anticipated pollution control costs connected with the operation together with writeoff costs made the action necessary, according to Foote.

Diamond Shamrock Corp. dedicated its new chromium chemicals plant at Castle Haynes, N.C., which began operation late in 1971. Reportedly the plant will process South African chromite.

A worldwide survey on chromium supply and demand was published early in the year.[4] This study presented information on supply and demand as well as worldwide trade by principal countries.

CONSUMPTION AND USES

Domestic consumption of 1,140,000 tons of chromite ore and concentrate containing about 353,000 tons of chromium was 4% higher than in 1971. Of the total chromite consumed, the metallurgical industry used 63.8%, the refractory industry 19.6%, and

[3] Federal Register. V. 37, No. 226, Nov. 22. 1972, p. 24838.

[4] Roskill Information Services Ltd. Chromium Minerals, Ferrochrome, Chromium and Chromium Chemicals: World Survey of Production and Consumption With Special Reference to Future Demand and Prices. London, January 1972, 236 pp.

the chemical industry 16.6%. The metallurgical industry consumed 727,000 tons containing 238,000 tons of chromium in producing 350,000 tons of chromium alloys and chromium metal. About 68.7% of the metallurgical-grade ore had a chromium-to-iron ratio of 3:1 and over; 18.5% had a ratio between 2:1 and 3:1; and 12.8% had a ratio of less than 2:1.

Producers of chromite-bearing refractories consumed 224,000 tons of ore containing 55,000 tons of chromium. The chemical industry consumed 189,000 tons of chromite containing 59,000 tons of chromium in producing 147,000 tons of chemicals (sodium bichromate equivalent).

The technologic change in manufacturing stainless steel, that of decarburizing a molten bath by one of several processes, was reflected in both production and consumption of chromium alloys. Domestic producers switched their product mix to a higher proportion of lower cost high-carbon ferrochromium to meet consumer demand. Consumers in 1971 used about equal quantities of high-carbon and low-carbon ferrochromium; whereas in 1972 the ratio was 1.5:1.

Chromium has a wide range of applications in the metallurgical industry. Its principal use is in stainless and heat-resisting steels, but its use in alloy and tool steels, cast iron, nonferrous alloys, and welding and alloy hard facings rods and materials accounted for 30% of chromium alloy consumption.

The refractory industry used chromium in the form of chromite, primarily for manufacture of refractory bricks for use in metallurgical furnaces and ladles. Some chromite, however, is employed for refractory purposes in mortars and in ramming, castable and gunning mixes, or directly for furnace repair.

The chemical industry consumes chromite for manufacture of sodium or potassium dichromate, the base material for a wide range of chromium chemicals used in electroplating, pigments, leather processing,

Table 3.—Consumption of chromite and tenor of ore used by primary consumer groups in the United States

(Thousand short tons)

Year	Metallurgical industry		Refractory industry		Chemical industry		Total	
	Gross weight	Average Cr_2O_3 (%)	Gross weight	Average Cr_2O_3 (%)	Gross weight	Average Cr_2O_3 (%)	Gross weight	Average Cr_2O_3 (%)
1968	804	49.7	311	34.1	202	45.1	[1] 1,316	45.4
1969	898	49.1	302	35.0	211	45.1	1,411	45.5
1970	912	48.0	278	35.9	213	45.3	1,403	45.2
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

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

Table 4.—Production, shipments, and stocks of chromium ferroalloys and chromium metal

(Short tons)

Alloy	Production		Shipments	Producer stocks Dec. 31
	Gross weight	Chromium content		
1971:				
Low-carbon ferrochromium	111,861	78,056	104,143	26,730
High-carbon ferrochromium	132,169	88,977	146,643	28,370
Ferrochromium-silicon	92,145	35,983	86,020	19,823
Other [1]	17,426	13,069	15,899	4,851
Total	353,601	216,085	352,705	79,774
1972:				
Low-carbon ferrochromium	68,372	47,766	78,997	23,575
High-carbon ferrochromium	169,525	112,805	162,718	37,888
Ferrochromium-silicon	98,223	36,886	90,986	22,096
Other [1]	14,239	11,349	16,104	2,585
Total	350,359	208,806	348,805	86,144

[1] Includes chromium briquets, chromium metal, exothermic chromium additives, and other miscellaneous chromium alloys.

Table 5.—U.S. consumption, by end use, and consumer stocks of chromium ferroalloys and metal in 1972

(Short tons, gross weight)

End use	Low-carbon ferrochromium	High-carbon ferrochromium	Ferrochromium silicon	Other	Total
Steel:					
Carbon	1,255	2,498	470	W	4,223
Stainless and heat-resisting	93,851	122,189	56,036	176	272,252
Full alloy	15,103	37,415	4,499	3,471	60,488
High-strength low-alloy and electric	2,153	8,535	2,446	2,574	15,708
Tool	1,098	3,596	218	W	4,912
Cast irons	960	8,192	127	709	9,988
Superalloys	4,752	5,106	800	1,754	12,412
Alloys (excludes steels and superalloys):					
Welding and alloy hard-facing rods and materials	497	678	--	164	1,339
Other alloys [1]	1,049	1,112	W	2,449	4,610
Miscellaneous and unspecified	2,389	665	121	1,655	4,830
Total	123,107	189,986	64,717	[2] 12,952	390,762
Chromium content	83,460	122,521	25,387	8,030	239,398
Stocks December 31, 1972	10,666	1,206	3,391	[3] 1,304	27,422

W Withheld to avoid disclosing individual company confidential data, included in "Miscellaneous and unspecified."
[1] Includes magnetic and nonferrous alloys.
[2] Includes 3,591 tons of chromium metal.
[3] Includes 549 tons of chromium metal.

metal treatment, catalysts, and other applications.

The proposed Highway Safety Act of 1973 could lead to significantly increased use of chrome yellow paint for marking the Nation's highways. Chrome yellow (lead chromate) not only has high visibility, but also has good resistance to degradation by light and resistance to chemicals used to remove snow and ice from pavements. Chrome yellow contains a nominal 16% chromium.

STOCKS

Chromite stocks dropped significantly during the year as all three consuming industries reduced their inventories. Stocks decreased 10% in the metallurgical industry, 31% in the refractory industry, and 19% in the chemical industry compared with 1971 totals. Combined producer and consumer stocks of chromium alloys increased nearly 9%.

Stocks of chromium chemicals (sodium bichromate equivalent) at producer plants decreased from 14,271 tons in 1971 to 13,936 tons in 1972.

Table 6.—Consumer stocks of chromite, Dec. 31

(Thousand short tons)

Industry	1968	1969	1970	1971	1972
Metallurgical	396	296	387	667	601
Refractory	309	301	235	233	160
Chemical	207	143	111	119	96
Total	912	740	733	1,019	857

PRICES

Reversing the past 5-year trend, the published price for Soviet-metallurgical-grade chromite for 1972 delivery was 13 to 15% lower than in 1971. Based on 48% Cr_2O_3, 4:1 chromium-to-iron ratio, f.o.b. Russian ports, the price was quoted at $45.00 to $46.50 per metric ton. An adequate stock level and lower demand for chromite as a result of the high level of ferrochromium imports were responsible for the lower price quotation. Published price for Turkish chromite 48% Cr_2O_3, 3:1 ratio, per long ton, delivered Atlantic ports was $55 to $56; unchanged from the 1971 price. However, industry sources indicated that Turkish chromite was priced at $43 to $47 per long ton. South African Transvaal chromite 44% Cr_2O_3, no ratio, delivered Atlantic ports was quoted at $25 to $27 per long ton until April and $24 to $27 for the balance of the year.

Strong competition from imported chromium alloys resulted in lower prices of chromium to consumers. For instance, the price of imported charge chromium started the year at 21 cents per pound of chromium, or 2 cents below the 23 cents per pound for domestic material. In April, the imported price dropped to a range of 20 to 21 cents per pound of chromium. To meet foreign competition, domestic producers lowered their price to 20 cents per pound in July, which caused a further reduction in the price of imported material to 19 to 19.5 cents per pound of chromium. In November, the domestic price for charge chromium ceased to be published. A similar price situation developed for domestic high-carbon ferrochromium which started the year at 26.7 cents per pound of contained chromium which was reduced to 23.7 cents in July. The price was withdrawn in October.

Selected chromium alloy prices published by Metals Week at midyear (July 13, 1972) were as follows:

Material	*Cents per pound of chromium*
High-carbon ferrochromium	23.7
Charge chromium	20.0
Imported charge chromium	19.0–19.5
Low-carbon ferrochromium (0.025% carbon)	39.5
Low-carbon ferrochromium (0.05% carbon)	38.0
Imported low-carbon ferrochromium (0.05% carbon)	35.0–36.0
Blocking chromium (high-silicon)	28.6
	Cents per pound product
Aluminothermic chromium metal	115
Electrolytic chromium metal	130

FOREIGN TRADE

Both exports and reexports of chromite dropped significantly compared with those of 1971; exports decreased 42% while reexports dropped 61%. Export shipments were to Mexico, 51%; Canada, 49%; and small quantities to three other countries. Reexports were shipped to five countries; Canada, 55%; Mexico, 33%; Spain, 7%; Ireland, 4%; and Morocco, 1%.

Ferrochromium exports increased 40% to 12,861 tons valued at $4,341,539. West Germany, 36%; Canada, 30%; United Kingdom, 23%; and Sweden, 9% were the leading recipients of shipments. Reexports of ferrochromium decreased to 78 tons from 625 tons in 1971. Canada received 86% of the reexports.

Chromium and chromium alloys (wrought and unwrought) and waste and scrap exports totaled 200 tons valued at $303,576. Of the 24 countries receiving shipments, Canada accounted for 23%, Jamaica 16%, Venezuela 10%, and the Netherlands 9%.

Exports of pigment-grade chromium chemicals totaled 166 tons, valued at $290,340. Canada received 54% of the shipments and the balance was dispersed among 18 countries. Exports of non-pigment-grade chromium chemicals totaled 1,265 tons valued at $1,526,092. Japan received 27%, Canada 19%, France 15%, Italy 9%, and 25 countries the balance.

Exports of sodium chromate and dichromate increased 31% compared with 1971 totals, rising to 4,035 tons. Canada was the leading recipient with 69% of the shipments, and 22 other countries accounted for the balance.

Imports of chromite in 1972 decreased 18% in quantity and 13% in value compared with 1971 totals. Imports from the U.S.S.R. rose 41% compared with those of 1971, while those from Turkey and the Republic of South Africa fell 70% and 41%, respectively.

Imports of ferrochromium accelerated, reaching a record high of 141,271 tons valued at $34,588,000. This compares with the former high year of 1971 when ferrochromium totaled 85,187 tons. The Republic of South Africa supplied 34% and Japan 21% of the low-carbon ferrochromium. High-carbon ferrochromium was supplied by the Republic of South Africa, 42%; Southern Rhodesia, 16%; and Finland, 9%.

Table 7.—U.S. exports and reexports of chromite ore and concentrates

(Thousand short tons and thousand dollars)

Year	Exports		Reexports	
	Quantity	Value	Quantity	Value
1970	41	2,582	73	2,572
1971	35	2,094	145	6,081
1972	20	824	57	1,946

Table 8.—U.S. imports for consumption of ferrochromium, by country [1]

(Short tons and thousand dollars)

Year and country	Low-carbon ferrochromium (less than 3% carbon)			High-carbon ferrochromium (3% or more carbon)		
	Gross weight	Chromium content	Value	Gross weight	Chromium content	Value
1971:						
Belgium-Luxembourg	--	--	--	110	71	25
Brazil	--	--	--	1,382	847	291
Canada	184	111	43	515	360	159
Finland	--	--	--	10,903	5,772	1,138
France	1,086	773	425	4,255	2,927	1,125
Germany, West	5,033	3,728	2,343	6,738	4,392	1,620
India	2,260	1,623	800	--	--	--
Japan	7,390	4,882	2,943	12,992	8,363	2,924
Norway	3,458	2,409	1,460	300	211	85
South Africa, Republic of	14,633	8,661	3,459	7,174	3,871	956
Sweden	5,434	4,036	2,492	220	151	52
Turkey	1,120	750	357	--	--	--
Total	40,598	26,973	14,322	44,589	26,965	8,375
1972:						
Belgium-Luxembourg	39	28	17	1,554	1,021	237
Brazil	--	--	--	4,205	2,535	651
Canada	45	30	17	--	--	--
Finland	--	--	--	6,887	3,612	681
France	465	336	177	--	--	--
Germany, West	2,949	2,163	1,211	2,316	1,519	501
Italy	--	--	--	1,653	1,075	320
Japan	14,134	9,598	5,434	3,577	2,267	736
Netherlands	--	--	--	827	556	183
Norway	6,282	4,505	2,422	3,318	2,272	766
Rhodesia, Southern	3,578	2,581	1,403	11,835	8,075	1,910
South Africa, Republic of	23,095	14,406	5,955	30,890	17,113	4,361
Sweden	9,608	7,125	3,958	1,171	796	269
Turkey	6,882	4,703	2,312	--	--	--
Yugoslavia	1,117	774	416	4,844	3,176	651
Total	68,194	46,249	23,322	73,077	44,017	11,266

[1] Revisions in 1969: Less than 3% carbon Western Africa n.e.c.—deleted. Republic of South Africa should read gross weight 22,050 short tons, chromium content 13,706 short tons ($5,503); 1970; delete Mozambique, Republic of South Africa should read gross weight 1,120 short tons, chromium content 620 short tons ($140).

Four countries, Norway, the Republic of South Africa, Southern Rhodesia, and Sweden, supplied 8,427 tons of ferrochromium-silicon valued at $846,106. Southern Rhodesia accounted for 72% of the total.

Chromium carbide imports from West Germany and the United Kingdom totaled 158 tons valued at $459,519. West Germany accounted for nearly 93% of the total.

Imports of chromium metal, unwrought and waste and scrap, increased to 1,894 tons from 1,632 tons in 1971. Total value rose to $3,791,079 from $2,965,641. Of the seven countries supplying imports, the United Kingdom accounted for 60% and Japan 27%.

Imports of chromium-containing pigments were as follows: Chrome green, 450 tons; chrome yellow, 7,530 tons; chromium oxide green, 1,383 tons; hydrated chromium oxide green, 183 tons; molybdenum orange, 659 tons; strontium chromate, 3 tons; and zinc yellow, 1,461 tons. Total value of these products was $6.3 million, 40% higher than in 1971. Chromium yellow accounted for 60% of total value of these products. The leading supplier was Japan, which furnished 49% of total value.

Sodium chromate and dichromate imports totaled 5,748 tons valued at $1,159,815; 10% less than in 1971. Imports were principally supplied by U.S.S.R., 44%; Japan, 33%; and the Republic of South Africa, 10%.

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
1971:												
Finland	--	--	--	(1)	(1)	1	--	--	--	(1)	(1)	1
Iran	--	--	--	--	--	--	12	5	381	12	5	381
Pakistan	--	--	--	--	--	--	35	17	1,013	35	17	1,013
Philippines	147	48	3,055	12	5	207	--	--	--	159	53	3,262
Rhodesia, Southern	--	--	--	--	--	--	26	12	768	26	12	768
South Africa, Republic of	11	4	134	271	120	3,177	140	65	1,961	422	189	5,272
Turkey	83	32	1,894	75	33	2,313	180	85	6,056	338	150	10,263
U.S.S.R.	33	13	r 812	--	--	--	274	151	r 10,101	307	164	r 10,913
Total	274	97	r 5,895	358	158	5,698	667	335	r 20,280	1,299	590	r 31,873
1972:												
Iran	--	--	--	14	6	346	--	--	--	14	6	346
Malagasy Republic	13	4	390	--	--	--	--	--	--	13	4	390
Pakistan	--	--	--	--	--	--	27	13	909	27	13	909
Philippines	122	39	2,835	--	--	--	9	4	201	131	43	3,036
Rhodesia, Southern	--	--	--	27	12	876	65	31	1,876	92	43	2,752
South Africa, Republic of	--	--	--	141	62	1,704	108	51	1,520	249	113	3,224
Turkey	32	13	742	13	6	368	56	34	1,804	101	53	2,914
U.S.S.R.	63	24	909	--	--	--	371	202	13,147	434	226	14,056
Total	230	80	4,876	195	86	3,294	636	335	19,457	1,061	501	27,627

r Revised.
[1] Less than ½ unit.

Table 10.—U.S. import duties

Tariff classification	Articles	Rate of duty, Jan. 1, 1973 [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 cent 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 Communist countries.
[2] Duty temporarily suspended on waste and scrap.

WORLD REVIEW

Brazil.—Cia. de Ferro Ligas da Bahia, S.A. (FERBASA) continued to be Brazil's principal producer of chromite and ferrochromium. Early in 1972, following a period of negotiations initiated in 1971, FERBASA reached an agreement with several Japanese groups (Mitsui & Co. and others) to form a new company, called Cia. de Mineração Serra da Jacobina (SERJANA), which will conduct exploration work for new chromite deposits. At the present time, the Japanese will not participate in FERBASA's ferrochromium operations. FERBASA plans to increase its low-carbon ferrochromium production with the installation of a 3,500-kilovolt-ampere electric furnace. Annual production capacity of the enlarged plant will be on the order of 5,512 short tons per year.

Brazilian Chrome Resources Development (BCRD) initiated an exploration program to develop additional reserves at the Pedrinhas chromium mine in the State of Bahia. Chromite is mined at Pedrinhas to supply FERBASA and for export. BCRD is owned by two Japanese trading companies and six Japanese consumers.

New Guinea.—American Metal Climax Inc. (AMAX) continued to explore a chromite deposit near the Sela River south of Lae.

Table 11.—Chromite: World production by country

(Thousand short tons)

Country [1]	1970	1971	1972 p
Albania	516	e 589	e 671
Brazil	30	e 31	e 33
Colombia	(2)	1	e 1
Cyprus	37	45	33
Finland	133	123	e 123
Greece	29	27	e 26
India	299	288	310
Iran e	220	194	198
Japan	36	35	27
Malagasy Republic	3 144	154	e 154
Pakistan	32	27	36
Philippines	624	476	388
Rhodesia, Southern e	400	400	400
South Africa, Republic of	1,573	1,812	1,635
Sudan	52	23	25
Turkey	572	665	e 710
U.S.S.R. e	1,930	1,980	2,040
Yugoslavia	45	38	31
Total	6,672	6,908	6,841

e Estimate. p Preliminary.
[1] In addition to the countries listed, Argentina has produced less than 500 tons of chromite annually in each of the three years listed in the table, and Bulgaria, Cuba, North Korea and North Vietnam also produce chromite but available information is inadequate to make reliable estimates of output levels.
[2] Less than ½ unit.
[3] Exports.

India.—In 1969, the Geological Survey of India (GSI) initiated an extensive study of chromite occurrences in Andhra Pradesh, Bihar, Maharashtra, Mysore, Orissa, and Tamil Nadu, and has since assisted in the conservation of existing ore and in the improvement of the small-mine industry's operating methods. Currently, the GSI places the total chromite reserve at 13.9 million tons. Of the total, lump ore comprises 1.6 million tons; fines 4.7 million tons, and unclassified ore 7.6 million tons. A breakdown by type of ore indicates 3.9 million tons represents metallurgical and chemical-grade ores, and 10 million tons refractory-grade ore.

India's chromite production in 1971 decreased nearly 4% compared with that of 1970. However, the value of chromite production increased from $2.1 million in 1970 to $2.5 million in 1971. For the third consecutive year all chromite exports were to Japan. Shipments by grade of ore were as follows: Over 48% Cr_2O_3, 59,304 tons; 38 to 48% Cr_2O_3, 15,653 tons; and below 38% Cr_2O_3, 30,606 tons.

Ferrochromium production decreased from 14,708 in 1970 to 13,756 tons in 1971. The major producer, the privately owned Ferroalloy Corp. Ltd., accounted for 80% of India's output while the public sector firm, Industrial Corp. of Orissa, Ltd., produced 15%. The balance was produced by three other concerns, one of which was in the public sector. Ferrochromium exports fell sharply in 1971 to 4,625 tons from 9,274 in 1970. The United States received 52% of total exports.

A recently revised study by the Government of India Planning Commission estimates India's chromite demand pattern through 1983 as follows: 1973, 330,000 tons; 1978, 386,000 tons; and 1983, 408,000 tons.

Iran.—The Industrial Development and Renovation Organization of Iran was reported to be planning construction of a ferrochromium plant near Bandar Abbas with an annual capacity of 50,000 tons.

Malagasy Republic.—In 1972 Cie. Minière d'Andriamena (Comina) cutback production of chromite at its Malagasy mine owing to sales difficulty. In 1971, Comina stockpiled about six months output because of lack of sales. France and Japan are the principal recipients of Malagasy chromite.

Pakistan.—The West Pakistan Industrial Corp. (WPIDC) is a semi-government agency which plans and supports industrial projects in Pakistan. WPIDC earmarked $2.3 million for a ferrochromium processing plant in the North West Frontier Province, 74% of which would be financed by Chinese credit.

Philippines.—Output of chromite decreased 18% compared with that of 1971; 77% was classified as refractory-grade and 23% metallurgical-grade. Exports of refractory-grade chromite totaled 314,229 tons. The United States received 47%, Japan 15%, and the United Kingdom 12%; the balance was shipped to nine other countries. Japan received all of the 75,919 tons of metallurgical-grade chromite exported.

Rhodesia, Southern.—United Nations economic sanctions, which were applied in 1966, brought retaliation by the Rhodesian Government in the form of an embargo on mining news, primarily production data. Firm production data has been unavailable since 1965.

Rio Tinto (Rhodesia) Ltd. (RTR) reportedly requested government approval for building a chromium smelter complex at Eiffel Flats near Gatooma. Production could occur in 1975 depending on world demand and government approval. The company was also considering using the facilities as a custom smelter. In preparation, RTR acquired the total share capital of Rhodesian Mining Enterprises Ltd. and the claims and assets of Great Dyke Chrome Mines Ltd. Rhodesian Mining had two mines in operation, the Jester and Feoch mines, and the O'Meath mine on standby. Great Dyke Chrome mines held a large number of claims in the Darwendale area of the Great Dyke. RTR also had an option to purchase the entire share capital of Frances Mines Ltd.

South Africa, Republic of.—Chromite production in the Republic of South Africa totaled 1,635,000 tons and was down 10% compared with 1971 figures. Of the total, 504,000 tons was classified as less than 44% Cr_2O_3; 1,078,000 tons from 44 to 48% Cr_2O_3; and 53,000 tons as over 48% Cr_2O_3. Local sales of chromite accounted for 359,000 tons and exports 1,386,000 tons. Local sales and exports moved in opposite directions compared with 1972; local sales decreased 19% while exports increased 8%.

Despite the downturn of chromite production in South Africa, the Transvaal Consolidated Land and Exploration Co., Ltd., a subsidiary of Barlow Rand Ltd., reported annual chromite sales increased for its reporting period ending September 30. According to the firm's annual report, the group owns a substantial portion of South Africa's chromite reserves and the combined production of its three mines makes it the largest single producer of chromite in South Africa.

Initial work has been completed on increasing chromite production at the Grasvally Chrome mine owned by African Metal Corp. Ltd. (AMCOR) and operated by Cromore Ltd. Mining began in 1962 and for the past eight years production ran about 500 tons per month. The current expansion project when completed in early 1976 will bring production capacity to 275,000 tons annually, of which 220,000 will be available for export.

South Africa's ferrochromium output received a major boost when the Associated Manganese Mines of South Africa and United States Steel Corp.'s new plant at Machadodorp came into production in December. Full production capacity of the plant will be about 4,409 short tons per month.

AMCOR's new chromium ferroalloy furnace was near completion at yearend. The new furnace with a rated capacity of 50,000 tons of charge chromium annually will bring AMCOR's total ferroalloy production capacity to 125,000 tons annually, of which 80% will be available for export.

Sweden.—Airco Alloys AB, a wholly owned subsidiary of Airco Alloys and Carbide Div. of Airco Inc., brought onstream a 75,000-kilovolt-ampere furnace, reportedly the largest in the world for ferroalloy production. Although being used for ferrosilicon production, the firm also plans on using the facility for production of ferrochromium. The new unit replaces four smaller units at the plant and is equipped with a sand filter dust control system for removing pollutants.

Turkey.—Etibank was authorized to develop chromite deposits near Cakmak, Islahiye, Turkey. The agreement calls for extracting 500 tons of chromite per year. Etibank also signed similar agreements for development of chromite deposits at Kirkpinar and Kuzoluk.

International Mining Corp., Chrome Resources S.A., and Foote Mineral Co. joined forces to construct a plant for concentration of chromium ore in Turkey. Shipments of chromium concentrate were expected to begin late in the year.

Yugoslavia.—The geology of Yugoslavian chromite deposits was described.[5]

[5] Grafenauer, S. Recent Results on Alpine-Type Chromite Deposits. Mining Met. Quart., (Rudarskometalurski Zbornic, No. 1, 1971, pp. 1–10) translated from Slovenian, 1972, pp. 5–14.

TECHNOLOGY

Processes for the production of stainless steel continue to be developed and improved. Most of the processes utilize lower cost high-carbon ferrochromium rather than higher cost low-carbon ferrochromium.

Joslyn Stainless Steel, a division of Joslyn Manufacturing and Supply Co. and a pioneer in the development of the argon-oxygen decarburization (AOD) process, believes that it has perfected a process for substituting nitrogen for a significant part of the argon used in the process. Spartan Steel and Alloy Ltd. (United Kingdom) also found that nitrogen can partially replace the more expensive argon.

Allegheny Ludlum, Inc., teamed up a basic oxygen furnace (BOF) with a hot blast cupola furnace at its Natrona, Pa., plant.[6] Stainless steel scrap, high-carbon ferrochromium, and molybdenum oxide are cold charged to the BOF furnace to which the cupola hot metal is added. Optimum charge rate has been 66.5% hot metal. Chromium recovery rates range from 88.7 to 92.5%.

For the production of most nickel stainless steel grades, Allegheny utilizes a vacuum refining process (AVR) which employs an electric furnace for melting and a vacuum refining unit. Decarburizing is achieved by injecting oxygen below the liquid metal surface while it is held at reduced pressure. Chromium yield in the AVR unit was reported at 98.1% and overall chromium recovery at 92.6%.[7]

Sweden's Uddeholm Steel Corp. developed a stainless steel process similar to the AOD process, but in place of argon to carry off the carbon monoxide, water vapor is injected through the furnace bottom. Reduced refractory wear is claimed; however, the process is limited to stainless grades containing less than 0.15% carbon. The firm reports a savings of $8 per ton in the manufacturing of stainless steel.

Outokumpu Oy (Finland) continued to develop a process for the production of electrolytic chromium. Chromium metal containing 200 to 300 ppm oxygen, 20 to 40 ppm nitrogen, and 10 ppm sulfur was purified in bulk to less than 1 ppm oxygen, 5 ppm nitrogen, and less than 5 ppm sulfur. The material was then processed into a wrought bar by direct extrusion in an evacuated sheath.[8] Small quantities of interstitial elements in chromium metal in the past has prevented processing commercial chromium metal to ductile metal.

An improved electrorefining process was developed for the preparation of high-purity chromium with low-interstitial content. High-purity commercial chromium metal was electrorefined in a chromic chloride ($CrCl_2$) electrolyte at cathode current densities of 40 to 210 amperes per square foot. Average current efficiency and chromium recovery were 96% and 99%, respectively.[9]

Two new chromium plating processes were developed that could substantially reduce repair and salvage costs. The first was an electrolytic process that can be taken to the automobile bumper. The second was a hard chromium plating system primarily intended for use in moldmaking and tool and die operations for salvaging worn or mismatched parts.

The Central Research Institute (India) reported the development of a self-regulating, high-speed chromium salt. The performance characteristics of the formulation demonstrate the following advantages over conventional plating: Higher production rate; formation of smoother, brighter, and harder deposits; less frequent need for accessories such as jigs; and elimination of control of critical constituents such as sulfate.[10]

Bureau of Mines researchers determined low-temperature heat capacities and high-temperature enthalpies calorimetrically for sodium chromate.[11]

---

[6] Iron Age. Chromium Recovery Improved in Stainless Refining. V. 209, No. 23, June 8, 1972, pp. 59–60.

[7] Work cited in footnote 6.

[8] Sced. I. R. Production of High-Purity Wrought Chromium by Hydrogen Reduction and Extrusion Without Intermediate Melting. J. Less Common Metals, v. 27, No. 3, June 1972, pp. 261–267.

[9] Lei, K. P. V., J. M. Hiegel, and T. A. Sulivan. Electrolytic Preparation of High-Purity Chromium. J. Less-Common Metals, v. 27, No. 3, June 1972, pp. 353–365.

[10] Journal of Mines, Metals and Fuels. Formulation for High-Speed Chromium Plating. V. 20, No. 4, April 1972, p. 124.

[11] Ferrante, M. J., J. M. Stuve, and M. P. Krug. Low-Temperature Heat Capacities and High-Temperature Enthalpies of Sodium Chromate. BuMines RI 7691, 1972, 12 pp.

Geological studies on chromite included a discussion of occurrences in Sabah, North Borneo and in the lavas from volcano eruptions in Hawaii.[12]

---

[12] Hutchison, Charles S. Alpine-Type Chromite in North Borneo, With Special Reference to Darvel Bay. Am. Mineralogist, v. 57, Nos. 5–6, May–June 1972, pp. 835, 856.
Evans, Bernard W. and Thomas L. Wright. Compostion of Liquidus Chromite from the 1959 (Kilavea Iki) and 1965 (Makaopuhi) Eruptions of Kilavea Volcano, Hawaii. Am. Mineralogist, v. 57, Nos. 1–2, January–February, 1972, pp. 217–230.

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, 5.2 million tons; and Ohio, 4.1 million tons; followed in order by North Carolina, Alabama, and California. Georgia also led in total value of clay output with $132.3 million; Wyoming was second with $18.5 million. Compared with 1971 figures, clay production increased in 31 States and value increased in 29 States. Total quantity of clays sold or used by domestic producers in 1972 was approximately 5% higher than in 1971, and total value was approximately 10% higher. Both the total tonnage and value of clays produced were alltime highs. Modest increases in value per ton were reported for all clays except fuller's earth and kaolin, which declined slightly in value.

Kaolin in 1972 accounted for only 9% of the total clay production but for 45% of the domestic clay and shale value.

Table 1.—Salient clay and clay products statistics in the United States [1]
(Thousand short tons and thousand dollars)

	1968	1969	1970	1971	1972
Domestic clays sold or used by producers	57,348	58,694	54,853	56,666	59,456
Value	$246,938	$264,415	$267,912	$274,431	$303,022
Exports	1,519	1,574	2,076	1,973	1,847
Value	$44,134	$45,767	$66,116	$65,329	$66,216
Imports for consumption	97	82	87	64	67
Value	$1,951	$1,750	$1,802	$1,501	$1,309
Clay refractories, shipments (value)	$229,660	$257,507	$256,384	$236,563	$274,679
Clay construction products, shipments (value)	$590,776	$608,982	$554,431	$641,567	$722,236

[1] Excludes Puerto Rico.

DOMESTIC PRODUCTION, PRICES, AND FOREIGN TRADE, BY TYPE OF CLAY

KAOLIN

Domestic production of kaolin in 1972 and its reported total value increased 9%. The average unit value for all grades of kaolin in 1972 was $25.75 per ton, $0.04 lower than in 1971. Kaolin was produced in mines in 17 States. Two States, Georgia (74.6%) and South Carolina (12.8%), accounted for 87.4% of the total U.S. production in 1972. Arkansas ranked third, Alabama fourth, and Texas fifth. Output in 1972 declined in Arizona, Arkansas, Idaho, Ohio, Oregon, and Utah. Increased production was noted in California, Florida, Georgia, Missouri, Nevada, North Carolina, Pennsylvania, South Carolina, and Texas. A new producing State in 1972 was Minnesota.

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 1972 Burgess Pigment Co. added an additional flash calciner at its Sandersville, Ga., facility, and Engelhard Minerals &

[1] Physical scientist, Division of Nonmetallic Minerals—Mineral Supply.

Table 2.—Clays sold or used by producers in the United States in 1972, by State [1]

(Short tons)

State	Quantity: Kaolin	Ball clay	Fire clay	Bentonite	Fuller's earth	Common clay and shale	Total	Total value
Alabama	112,152	--	350,094	W	--	2,388,062	[2] 2,850,308	[2] $7,511,918
Arizona	5	--	W	25,410	--	108,957	[3] 134,372	[3] 355,251
Arkansas	W	--	--	--	--	885,147	[4] 885,147	[4] 990,269
California	58,743	W	100,270	39,787	W	2,493,297	2,705,901	7,387,342
Colorado	--	--	54,294	929	--	691,718	746,941	1,533,214
Connecticut	--	--	--	--	--	156,723	156,723	291,864
Delaware	--	--	--	--	--	15,480	15,480	9,288
Florida	W	--	--	--	353,473	568,351	[4] 921,824	[4] 10,335,900
Georgia	3,966,443	--	W	--	405,170	1,855,555	[3] 6,227,168	[3] 132,321,567
Hawaii	--	--	--	--	--	W	W	W
Idaho	W	--	9,868	40	--	W	57,402	415,327
Illinois	--	--	106,003	--	W	1,609,537	[5] 1,715,540	[5] 3,314,068
Indiana	--	277	W	--	--	1,419,141	[3] 1,419,418	[3] 2,465,238
Iowa	--	--	--	--	--	1,047,466	1,047,466	2,642,705
Kansas	--	--	--	--	--	1,169,528	1,169,528	1,456,742
Kentucky	--	W	81,094	--	--	838,573	[6] 919,667	[6] 1,405,675
Louisiana	--	--	--	--	--	1,000,162	1,000,162	1,454,344
Maine	--	--	--	--	--	40,230	40,230	57,031
Maryland	--	W	3,319	--	--	1,101,140	[6] 1,104,459	[6] 2,121,195
Massachusetts	--	--	--	--	--	218,779	218,779	415,812
Michigan	--	--	--	--	--	2,513,808	2,513,808	3,714,690
Minnesota	W	--	--	--	--	167,412	[4] 167,412	[4] 251,119
Mississippi	--	W	--	277,596	W	1,496,694	1,918,773	7,836,817
Missouri	W	--	894,174	W	--	1,676,958	[2 4] 2,571,132	[2 4] 9,095,527
Montana	--	--	W	233,390	--	70,377	[3] 303,767	[3] 1,589,971
Nebraska	--	--	--	--	--	115,033	115,033	143,424
Nevada	W	--	--	W	--	W	40,227	182,809
New Hampshire	--	--	--	--	--	50,750	50,750	70,125
New Jersey	--	--	59,372	--	--	152,514	211,886	856,450
New Mexico	--	--	W	--	--	65,124	[3] 65,124	[3] 107,789
New York	--	W	--	--	--	1,600,723	[6] 1,600,723	[6] 1,919,417
North Carolina	W	--	--	--	--	3,862,435	[4] 3,862,435	[4] 4,473,183
North Dakota	--	--	--	--	--	W	W	W
Ohio	28,371	--	803,493	--	--	3,292,878	4,124,742	11,272,640
Oklahoma	--	--	--	W	--	937,683	[2] 937,683	[2] 1,397,874
Oregon	133	--	--	1,192	--	149,411	150,736	238,090
Pennsylvania	54,983	--	768,688	--	--	1,857,880	2,681,551	15,828,905
Puerto Rico	--	--	--	--	--	360,724	360,724	382,296
South Carolina	681,086	--	--	--	--	1,540,271	2,221,357	11,267,580
South Dakota	--	--	--	W	--	185,461	[2] 185,461	[2] 156,140
Tennessee	--	431,126	21	--	W	1,286,629	[5] 1,717,776	[5] 7,718,560
Texas	W	W	88,821	88,220	W	4,894,299	5,174,632	11,554,283
Utah	W	--	3,764	4,014	2,080	256,397	[4] 266,255	[4] 790,191
Virginia	--	--	--	--	--	1,634,024	1,634,024	1,783,350
Washington	--	--	W	--	--	264,093	[3] 264,093	[3] 583,539

West Virginia	--	--	W	--	--	274,310	[3] 274,310	[3] 402,927
Wisconsin	--	--	--	--	--	3,851	3,851	7,085
Wyoming	--	--	--	1,811,246	--	61,634	1,872,880	18,509,126
Undistributed	415,721	243,882	257,360	285,174	227,815	108,374	[7] 1,189,026	[7] 14,785,960
Total	5,317,637	675,285	3,580,635	2,766,998	988,538	46,487,593	59,816,686	303,404,617

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes Puerto Rico.
[2] Excludes bentonite.
[3] Excludes fire clay.
[4] Excludes kaolin.
[5] Excludes fuller's earth.
[6] Excludes ball clay.
[7] Incomplete total; remainder included in State totals.

Chemicals Corp. announced plans for expanding its calcined kaolin production capacity at McIntyre, Ga. Anglo-American Clay Corp. also announced expansion of its facilities at Sandersville. This expansion included new spray-drying equipment plus additional equipment to increase the production capacity of their high-brightness coating clays. Freeport Kaolin Co. and Georgia Kaolin Co. were installing large-capacity wet magnetic separators at their Georgia plants, while the J. M. Huber Corp. was expanding its existing magnetic separator facilities. Theile Kaolin Co. was also reportedly planning installation of magnetic separators at its Sandersville plant. High-intensity wet magnetic separators are used to remove iron-bearing contaminants from kaolin clays. Dresser Industries Inc. placed its new kaolin-calcining facility on stream at Kossee, Tex.

Kaolin was exported to 54 countries. The recipients were Japan, 24%; Canada, 22%; West Germany, 18%; Italy 12%; and the remaining countries, 24%. Generally, exports to all countries increased, except for those to Italy, France, West Germany, and Sweden which decreased 45%, 32%, 24%, and 10%, respectively. The kaolin producers reported the end use of their exports were paper coating, 48%; paper filling, 25%; rubber, 8%; and others, including firebrick, paint, and plastics, 19%.

Kaolin imports in 1972 continued the downward trend reported for a number of years, to 25,481 short tons valued at $736,000 from 44,622 tons valued at $907,000. The United Kingdom supplied over 96%; Canada, 3%; and 3 other countries supplied the remaining 1%.

Table 3.—Kaolin sold or used by producers in the United States, by State

State	1971		1972	
	Short tons	Value	Short tons	Value
Alabama	64,440	$646,619	112,152	$1,186,466
Arizona	65	1,350	5	150
California	48,191	494,881	58,743	522,198
Georgia	3,682,305	108,864,013	3,966,443	120,495,819
Indiana	76	608	--	--
Maryland	2,426	W	--	--
Nevada	1,500	W	W	W
Ohio	260,217	2,222,712	28,371	135,748
Oregon	213	5,020	133	670
Pennsylvania	W	W	54,983	613,167
South Carolina	449,522	7,954,113	681,086	8,997,932
Other States [1]	377,238	5,833,513	415,721	4,953,400
Total	4,886,193	126,022,829	5,317,637	136,905,550

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes Arkansas, Florida, Idaho, Minnesota, Missouri, Nevada, North Carolina, Texas, Utah.

Table 4.—Georgia kaolin sold or used by producers, by use

(Short tons)

Use	1971	1972
Paper coating	1,370,468	1,433,916
Paper filling	801,084	757,687
Firebrick and block	260,073	92,897
Whiteware	140,555	162,596
Rubber	128,436	143,395
Fiberglass	105,614	130,625
Paint	99,239	127,460
Plastics	78,365	66,844
Other chemicals	38,391	28,795
Exports	512,106	684,134
Other uses [1]	147,974	338,094
Total	3,682,305	3,966,443

[1] Includes cement, catalysts, floor and wall tile, other pottery, other refractories, insecticides and fungicides, foundry sand, and kiln furniture.

Table 5.—Georgia kaolin sold or used by producers in 1972, by kind

Kind	Short tons	Value
Airfloat	788,023	$10,317,785
Calcined	132,895	10,196,168
Delaminated	186,230	8,574,354
Unprocessed	217,527	4,832,833
Waterwashed	2,641,768	86,574,679
Total	3,966,443	120,495,819

Table 6.—Georgia kaolin sold or used by producers in 1972, by kind and use

(Short tons)

Use	Airfloat	Unprocessed	Water-washed [1]	Total
Adhesives	W	--	W	54,012
Brick, face	--	13,250	--	13,250
Crockery and other earthenware	19,995	--	--	19,995
Fiberglass	W	--	W	130,625
Firebrick, block, and shapes	73,509	19,388	--	92,897
Floor and wall tile, ceramic	18,385	--	--	18,385
Paint	W	--	W	127,460
Paper coating	16,100	--	1,417,816	1,433,916
Paper filling	256,903	--	500,784	757,687
Plastics	W	--	W	66,844
Pottery	W	--	W	10,765
Rubber	122,553	--	20,842	143,395
Sanitary ware	W	--	W	111,318
Miscellaneous:				
Animal feed; caulking, putty and sealers; linoleum; pesticides and related products	5,520	--	--	5,520
Catalysts (oil refining); foundry sand; unknown uses	15,763	--	--	15,763
China/dinnerware; glazes, glass, and enamels; roofing tile	21,012	--	--	21,012
Electrical porcelain; refractory grogs and crudes; and roofing granules	53,381	--	--	53,381
Aluminum sulfate; flue linings; refractory grogs and crudes; unknown uses	--	126,162	--	126,162
Catalysts (oil refining); chemical manufacturing; aluminum sulfate	--	--	41,842	41,842
Face brick; gypsum products; refractory mortar and cement	--	--	433	433
Fertilizers; ink; textiles	--	--	15,566	15,566
Medical, pharmaceutical, and cosmetic; foundry sand; ceramic tile; unknown uses	--	--	22,081	22,081
Undistributed	171,993	--	329,031	([2])
Total	775,114	158,800	2,348,395	3,282,309
Exports:				
Paint	--	--	23,395	23,395
Paper coating	--	--	361,431	361,431
Paper filling	1,834	--	181,632	183,466
Refractories	10,000	58,727	33	68,760
Rubber	1,075	--	3,109	4,184
Other	--	--	42,898	42,898
Total	12,909	58,727	612,498	684,134
Grand total	788,023	217,527	2,960,893	3,966,443

W Withheld to avoid disclosing individual company confidental data; included with "Undistributed."
[1] Includes calcined and delaminated.
[2] "Undistributed" total included with total for each specific use.

Table 7.—South Carolina kaolin sold or used by producers, by kind and use

(Thousand short tons)

Kind and use	1971	1972
Airfloat:		
Adhesives	NA	19
Fertilizers	W	42
Firebrick, block, and shapes	W	8
Paint	7	W
Pesticides and related products	8	23
Rubber	226	227
Exports	[1] 49	[2] 61
Other uses [3]	160	59
Total	450	439
Unprocessed: Face brick and firebrick and block, total	NA	242
Grand total	450	681

NA Not available. W Withheld to avoid disclosing individual company confidential data; included in "Other uses."
[1] End use not available.
[2] Fertilizers and rubber.
[3] Includes animal feed, chemicals (1971), fine china/dinnerware (1972), drilling mud (1971), fiberglass, floor and wall tile, gypsum products (1972), paper filling, pottery, (1972), sanitary ware (1972), whiteware (1971), other uses, and uses indicated by symbol W.

Table 8.—Kaolin sold or used as reported by producers in the United States in 1972, by kind and use

(Short tons)

Use	Airfloat	Unprocessed	Water-washed [1]	Total
Adhesives	W	--	W	73,417
Alum (aluminum sulfate) and other chemicals	--	27,471	83,534	111,005
Animal feed	W	133	W	9,452
Brick, face	W	284,507	W	285,268
Catalysts (oil refining)	W	36,880	W	67,990
Cement, portland	--	54,434	21,264	75,698
Ceramic—hobby	--	5	--	5
China/dinnerware	W	--	W	50,801
Crockery and other earthenware	19,995	--	--	19,995
Electrical porcelain	5,938	--	--	5,938
Fertilizers	W	--	W	75,969
Fiberglass	W	--	W	153,788
Firebrick, block, and shapes	84,739	252,608	--	337,347
Floor and wall tile, ceramic	43,235	200	--	43,435
Glazes, glass, and enamels	W	W	W	27,126
Grogs and crudes, refractory	W	W	--	153,541
Gypsum products	6,491	6,100	3,510	16,101
Paint	16,617	--	124,878	141,495
Paper coating	16,100	--	1,417,816	1,433,916
Paper filling	264,354	--	500,784	765,138
Pesticides and related products	25,306	--	3,136	28,442
Plastics	W	5,000	W	71,844
Pottery	13,355	W	W	23,743
Rubber	349,661	--	26,438	376,099
Sanitary ware	86,437	--	59,616	146,053
Miscellaneous	26,112	8,898	40,929	75,939
Undistributed	274,559	137,822	240,683	(2)
Total	1,232,899	814,058	2,522,588	4,569,545
Exports:				
Paint	--	--	23,395	23,395
Paper coating	--	--	361,431	361,431
Paper filling	1,834	--	181,632	183,466
Refractories	10,123	58,727	33	68,883
Rubber	59,525	--	3,109	62,634
Other	2,685	--	45,598	48,283
Total	74,167	58,727	615,198	748,092
Grand total	1,307,066	872,785	3,137,786	5,317,637

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes calcined and delaminated.
[2] "Undistributed" total included with total for each specific use.

Table 9.—U.S. exports of kaolin as reported by producers, by use

(Short tons)

Use	1971	1972
Paper coating	388,984	361,431
Paper filling	50,492	183,466
Rubber	49,806	62,634
Other [1]	72,090	140,561
Total	561,372	748,092

[1] Includes paint, plastics, refractories, and other uses.

BALL CLAY

Production and value reported for domestically mined ball clay in 1972 increased 12%. Tennessee mines provided 64% of the Nation's output, followed in order of output by Kentucky, Mississippi, Texas, California, Maryland, New York, and Indiana. Production in Kentucky, California, Maryland, Mississippi, and Tennessee increased over that reported in 1971.

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 1972 American-Olean Tile Co. announced plans for a future factory for manufacturing quarry tile at Roseville, Calif. NL Industries, Inc., acquired Bell Clay Co. of Gleason, Tenn. Bell's complete line of ball clays were to be marketed through NL Industries' TAM Division, and will supplement the clays and other materials that the division supplies.

The average unit value for ball clay reported by domestic producers rose in 1972 to $15.99 per ton, an increase of $0.04 per ton. Chemical Marketing Reporter, December 25, 1972, listed ball clay prices 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 1972 amounted to 87,000 short tons valued at $1.7 million, compared with 77,000 tons worth $1.5 million in 1971. Exports increased 13% over that shipped in 1971, while the value was 12% higher. The unit value of ball clay exported in 1972 declined $0.11 per ton, from $19.55 in 1971 to $19.44. These shipments were made to 21 countries. The major recipients were Canada, 48%, and Mexico, 44%; 19 countries accounted for the remaining 8%.

Table 10.—Ball clay sold or used by producers in the United States, by State

State	1971 Short tons	1971 Value	1972 Short tons	1972 Value
Tennessee	377,421	$5,455,628	431,126	$6,444,986
Other States [1]	225,203	4,156,589	244,159	4,350,539
Total	602,624	9,612,217	675,285	10,795,525

[1] Includes California, Indiana (1972), Kentucky, Maryland, Mississippi, New Jersey (1971), New York, and Texas.

FIRE CLAY

Fire clay sold or used by domestic producers in 1972 was reported at 3,580,635 short tons valued at $29.2 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 1972 from mines in 21 States. The first four States in rank, Missouri, Ohio, Pennsylvania, and Alabama, accounted for 79% of the total domestic output.

In 1972 Louisville Fire Brick Works increased capacity for special hand-molded firebrick shapes at its Grahn, Ky., plant.

Exports of fire clay decreased from 162,000 short tons worth $3.6 million in 1971 to 124,000 tons valued at $2.9 million

Table 11.—Fire clay sold or used by producers in the United States, by State [1]

State	1971 Short tons	1971 Value	1972 Short tons	1972 Value
Alabama	299,954	$2,736,448	350,094	$2,862,973
California	36,559	121,520	100,270	281,387
Colorado	42,512	242,084	54,294	206,158
Idaho	W	W	9,868	W
Illinois	89,725	513,504	106,003	661,752
Indiana	W	4,466	W	W
Kentucky	112,884	533,311	81,094	517,775
Maryland	--	--	3,319	11,617
Missouri	871,631	4,895,960	894,174	5,512,204
New Jersey	W	W	59,372	370,757
Ohio	658,229	3,567,757	803,493	5,127,052
Pennsylvania	559,128	4,172,685	768,688	9,809,806
Tennessee	23	46	21	42
Texas	74,814	W	88,821	684,400
Utah	W	W	3,764	21,790
Other States [2]	298,772	2,217,041	257,360	3,117,220
Total	3,044,231	19,004,822	3,580,635	29,184,933

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Refractory uses only.
[2] Includes Arizona (1972), Georgia, Iowa (1971), Montana, New Mexico, North Carolina (1971), South Carolina (1971), Washington, West Virginia, and data included by symbol W.

in 1972. Fire clay exports declined 23% in tonnage and 19% in value. The price of exported fire clay increased by $1.42 to $23.43 per ton.

Fire clay was exported to 41 countries, with Canada and Mexico receiving 40% and 38%, respectively. The other 39 countries received the remaining 22%. No imports of fire clay were reported during 1972.

There are no price quotations in domestic journals for fire clay, but the per-ton value reported by producers ranged from $2 to about $9. The reported average unit value for fire clay produced in the United States increased 31% from $6.24 per ton in 1971 to $8.15 in 1972.

BENTONITE

Bentonite production in 1972 increased 4% in tonnage and 5% in value over 1971. A general increase in domestic consumption, particularly in drilling mud, animal feed, and oil filtering uses, offset decreased exports and a decline in foundry sand applications.

Bentonite was produced in 15 States. Increased bentonite production was reported for all States except Arizona, Colorado, Idaho, Mississippi, Oklahoma, South Dakota, and Utah.

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.

Dust collection and control equipment was installed by Federal Bentonite Co. and Kaycee Bentonite Co. in their Wyoming plants.

Chemical Marketing Reporter, December 25, 1972, quoted bentonite prices as follows: Domestic, 200 mesh, bags, carload lots, f.o.b. mines, $14.00–$14.40 per ton; and imported Italian, white, high-gel, bags, 5-ton lots, ex-warehouse, $116.60 per ton. The average unit value reported by producers of domestic bentonite sold or used in 1972 was $10.60, a slight increase from the $10.46 average of the previous year. Per-ton values reported in the various producing States ranged from $3 to $23, but as in 1971, the average value reported by the larger producers was near the Wyoming average figure of $10.14.

Bentonite imports in 1972, including chemically activated and special-purpose Italian material, totaled 2,853 short tons valued at $229,000 compared with 2,393 tons valued at $194,000 in 1971. The 2,853 tons of chemically activated bentonite was imported from six countries, with Canada supplying 49%; Mexico, 29%; West Germany, 11%; Japan, 10%; and Ireland and the United Kingdom the remaining 1%. Imports of Italian bentonite in 1972 increased from 66 short tons in 1971 to 127 tons.

Bentonite exports in 1972 decreased from 663,000 short tons in 1971 valued at $16.2 million to 521,000 tons valued at $15.1 million. Although the tonnage exported decreased 21% from that shipped in 1971, the value decreased only 7%. The lesser decline in value was the result of the unit value of exported bentonite increasing $4.58 per ton, from $24.43 per ton in 1971 to $29.01 per ton. This increase in per ton value was attributed to a large decline in

Table 12.—Bentonite sold or used by producers in the United States, by State

State	1971		1972	
	Short tons	Value	Short tons	Value
Arizona	W	W	25,410	$284,660
California	33,932	$1,047,583	39,787	923,027
Colorado	1,548	7,742	929	6,043
Idaho	W	W	40	120
Mississippi	280,635	3,396,447	277,596	3,387,514
Missouri	42,503	W	W	W
Montana	228,624	1,663,732	233,390	1,489,361
Oregon	845	10,140	1,192	14,309
Texas	W	W	88,220	1,127,937
Utah	4,051	30,652	4,014	43,803
Wyoming	1,751,858	17,267,091	1,811,246	18,359,756
Other States [1]	321,763	4,468,428	285,174	3,693,987
Total	2,665,759	27,891,815	2,766,998	29,330,517

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes Alabama, Nevada, Oklahoma, South Dakota, and data indicated by symbol W.

the amount of lower cost bentonite shipped for iron ore pelletizing. 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 reportedly being blended with the U.S. clay for pelletizing Canadian taconite ores on a large scale.

Bentonite was exported to 71 countries, a decrease of 4 from the previous year. The major recipients were Canada, 56%; Australia, 9%; West Germany, 7%; United Kingdom and Singapore, 6%; each; and others, 16%. Domestic bentonite producers reported the end use of their exports were iron ore pelletizing, 43%; foundry sand, 40%; drilling mud, 13%; and others, including animal feed, oil refining catalysts, and waterproofing and sealing, 4%.

Table 13.—U.S. exports of bentonite as reported by producers in 1972, by use

Use	Short tons
Drilling mud	56,666
Foundry sand	167,130
Pelletizing (iron ore)	183,458
Other [1]	15,840
Total	423,094

[1] Includes animal feed, oil refining catalysts, waterproofing and sealing, and other uses.

FULLER'S EARTH

Production of fuller's earth in 1972 declined 3% in quantity and the total value declined 5%. The unit value assigned by domestic producers decreased $0.61 in 1972 to $23.08 per ton. This decrease in value was due primarily to the lower values reported by Florida producers. Georgia producers reported modest increases in unit value.

Fuller's earth production was reported from operations in eight States. The top two producing States, Georgia (41%) and Florida (36%), accounted for 77% of the domestic production. The other six States accounted for the remaining 23%. Georgia, Mississippi, and Tennessee showed gains in production, while Illinois, California, Florida, Texas, and Utah declined.

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 1972, but the per-ton values reported by producers ranged from $14 to about $29.

Table 14.—Fuller's earth sold or used by producers in the United States, by State

State	1971		1972	
	Short tons	Value	Short tons	Value
Florida	432,689	$12,220,273	353,473	$9,709,923
Georgia	348,043	7,729,590	405,170	9,053,440
Utah	2,580	50,591	2,080	41,857
Other States [1]	230,602	4,019,162	227,815	4,012,899
Total	1,013,914	24,019,616	988,538	22,818,119

[1] Includes California, Illinois, Mississippi, Tennessee, and Texas.

Exports of fuller's earth to 40 countries increased from 27,000 short tons in 1971 to 39,000 tons valued at $1.7 million in 1972. Export tonnage increased 44% and its valued increased nearly 47%. The unit value of exported fuller's earth rose nearly $0.68 per ton. The major recipients were the United Kingdom, 26%; Canada, 21%; and other countries, the remaining 53%.

Imports of fuller's earth in 1972 were 43 short tons valued at $3,000, all from the United Kingdom. Imports increased nearly 23%.

COMMON CLAY

The domestic production of common clay and shale in 1972 totaled 46.1 million short tons valued at $74.0 million. Com-

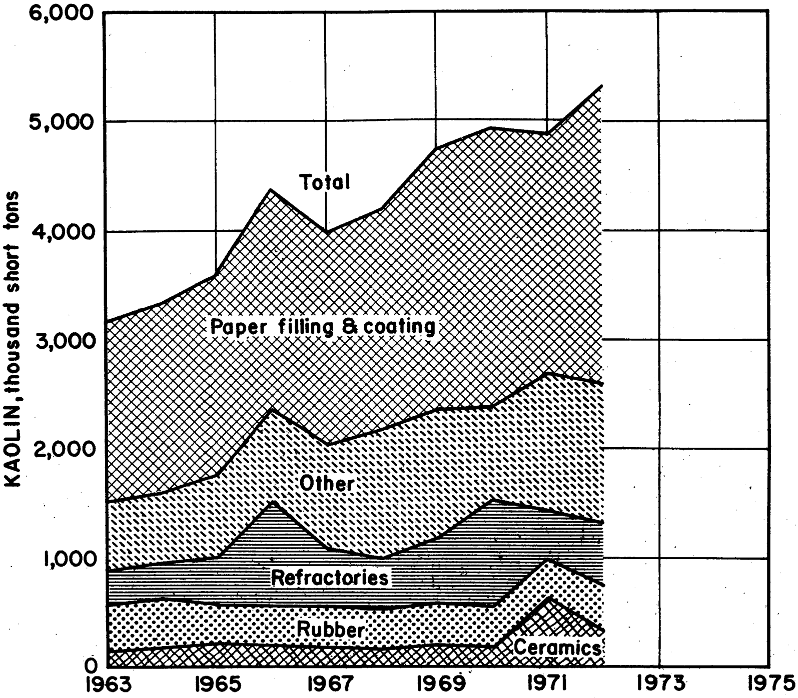

Figure 1.—Kaolin sold or used by domestic producers for specified uses.

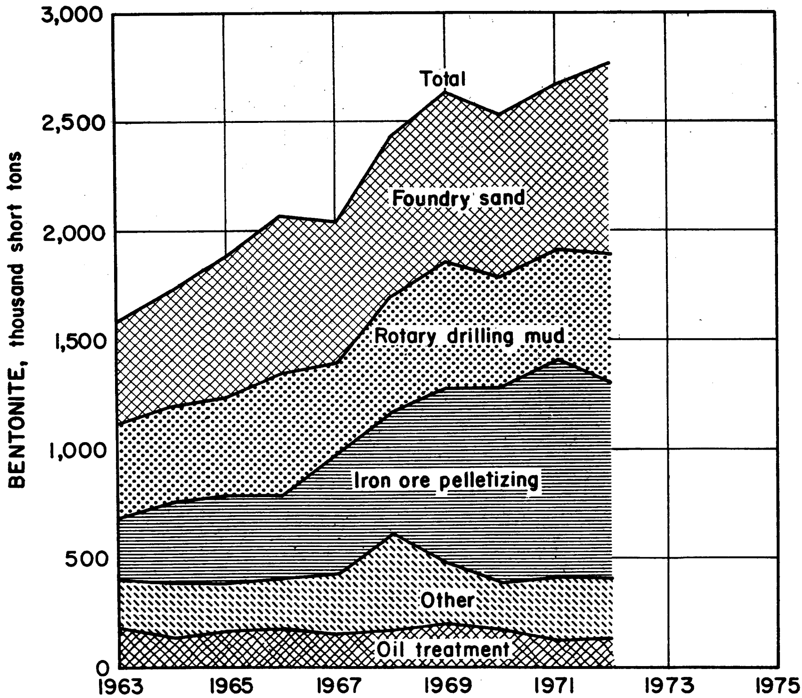

Figure 2.—Bentonite sold or used by domestic producers for specified uses.

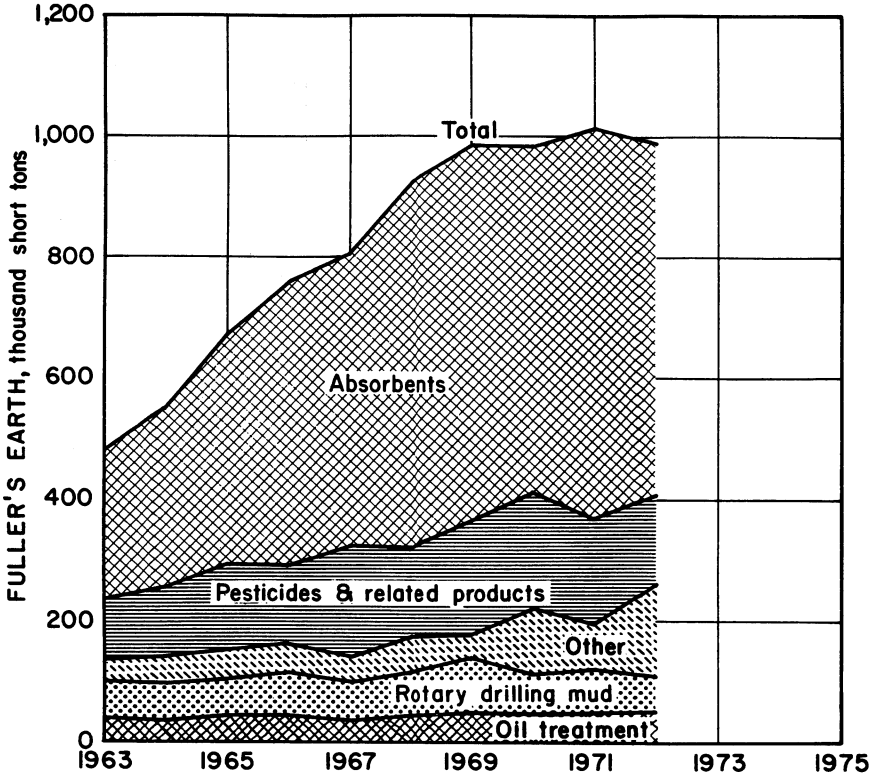

Figure 3.—Fuller's earth sold or used by domestic producers for specified uses.

mon clay and shale represented 78% of the quantity and 25% of the value of the total clay and shale produced domestically in 1972. In addition, Puerto Rican production of common clay and shale was reported at 360,724 tons valued at $382,296. Domestic output in 1972 increased 4% over that reported for 1971.

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 in 1972 was $1.60 per short ton, $0.08 more than in 1971. 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 claylike material which is sufficiently plastic to permit ready molding and vitrification below 1,100° C. Shale is a consolidated sedimentary rock composed chiefly of clay minerals which has been both laminated and indurated during burying 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.

During 1972 General Shale Products Corp. and Pine Hall Brick and Pipe Co. announced plans to increase brick production capacities. General Shale's expansions

Table 15.—Common clay and shale sold or used by producers in the United States, by State [1]

State	1971		1972	
	Short tons	Value	Short tons	Value
Alabama	2,550,806	$3,529,777	2,388,062	$3,462,479
Arizona	119,003	83,048	108,957	70,441
Arkansas	936,048	1,499,500	885,147	990,269
California	2,702,046	5,419,459	2,493,297	5,507,604
Colorado	581,174	1,084,672	691,718	1,321,013
Connecticut	174,165	322,069	156,723	291,864
Delaware	13,918	8,351	15,480	9,288
Florida	559,853	613,391	568,351	625,977
Georgia	1,760,374	2,502,695	1,855,555	2,772,308
Illinois	1,621,661	2,675,409	1,609,537	2,652,316
Indiana	1,324,294	2,302,673	1,419,141	2,462,468
Iowa	1,027,654	1,702,207	1,047,466	2,642,705
Kansas	879,426	1,151,078	1,169,528	1,456,742
Kentucky	843,411	844,071	838,573	887,900
Louisiana	1,073,417	1,606,173	1,000,162	1,454,344
Maine	42,180	56,077	40,230	57,031
Maryland	1,024,989	1,558,148	1,101,140	2,109,578
Massachusetts	185,732	376,883	218,779	415,812
Michigan	2,457,593	3,365,678	2,513,808	3,714,690
Minnesota	223,144	334,717	167,412	251,119
Mississippi	1,860,323	2,138,984	1,496,694	1,506,355
Missouri	1,439,738	2,558,227	1,676,958	3,583,323
Montana	34,898	48,567	70,377	100,610
Nebraska	69,401	82,358	115,033	143,424
New Hampshire	36,725	33,812	50,750	70,125
New Jersey	134,377	391,783	152,514	485,693
New Mexico	76,139	114,142	65,124	107,789
New York	1,588,012	1,742,467	1,600,723	1,919,417
North Carolina	3,502,879	3,801,769	3,862,435	4,473,183
Ohio	3,054,644	5,589,308	3,292,878	6,009,840
Oklahoma	844,617	1,254,585	937,683	1,397,874
Oregon	155,922	240,177	149,411	223,111
Pennsylvania	1,766,279	4,767,603	1,857,880	5,405,932
Puerto Rico	341,726	358,449	360,724	382,296
South Carolina	1,599,291	2,247,204	1,540,271	2,269,648
South Dakota	150,071	127,589	185,461	156,140
Tennessee	1,159,550	1,139,170	1,286,629	1,273,532
Texas	4,374,219	7,097,936	4,894,299	7,872,486
Utah	W	W	256,397	682,741
Virginia	1,709,859	1,799,879	1,634,024	1,783,350
Washington	255,203	548,547	264,093	583,539
West Virginia	232,178	335,565	274,310	402,927
Wisconsin	4,025	7,645	3,851	7,085
Wyoming	45,696	110,438	61,634	149,370
Other States [2]	258,558	665,615	108,374	224,235
Total	44,795,218	68,237,895	46,487,593	74,369,973

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes Puerto Rico.
[2] Includes Hawaii, Idaho, Nevada, North Dakota, and data indicated by symbol W.

were scheduled at its fully automated Knoxville, Tenn., plant and at Marion, Va. The expansion at Marion included a new 40-million-brick-per-year kiln. Pine Hall had broken ground for an addition to its No. 4 plant in Madison, N.C., which was completed and put into operation in 1970. The enlarged facility would double Pine Hall's capacity by increasing production by 40 million bricks. Alliance Brick Corp. was purchased by the Whitacre-Grier Fireproofing Co. of Waynesburg, Ohio. Whitacre presently devotes its production equally to refractories for the steel industry and architectural clay products. Alliance's modern brick plant with its two tunnel kilns was viewed as supplementing Whitacre's operations. An enlargement of its Tulsa, Okla., plant from a present capacity of 16 million bricks per year to 40 million per year was outlined by the Acme Brick Co. The Oklahoma Brick Corp., of Oklahoma City, Okla., also announced plans to fully automate its clay brick plant. The kilns in the newly automated facility will highlight a highly efficient moisture removal system.

Georgia Lightweight Aggregate Co. has contracted with Fuller Co., Catasauqua, Pa., for a new rotary kiln processing system to be installed at its Rockmart, Ga., plant late in 1972. Dust collecting and control systems were scheduled for the Erwindale, La., plant of Big River Industries, Inc., and at Vulcan Material Co.'s expanded shale plant near Bessemer, Ala. The Onondaga Lightweight Aggregate Corp.'s newly acquired fly ash sintering plant in Queens, N.Y., formerly owned by Consolidated Edison, was successfully moved, renovated, and put on stream producing the corporation's aggregate, Onolite. Plainville Corp. unveiled its redesigned "Masslite" expanded shale facility at Plainville, Mass. The redesigned Masslite plant features a more efficient operation and environmental controls.

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 which are adequate for manufacturing structural clay products, cement clinker, and lightweight aggregates, and thus have no need to import such material.

CONSUMPTION AND USES

The manufacturing of heavy clay products (building brick, sewer pipe, drain tile), portland cement and clinker, and lightweight aggregate accounted for 38%, 21%, and 18%, respectively, of the total 1972 domestic consumption of clays. In summary, 77% of all clay produced in 1972 was consumed in the manufacture of these clay- and shale-based construction materials. The above clay tonnage relationships were similar to those reported for 1971. The utilization of clays in 1972 for heavy clay products and portland cement increased 2% and 8%, respectively, over that reported in 1971. This increased clay consumption in building products reflected the general increase in construction activity.

Heavy Clay Products.—The values reported for shipments of heavy clay products in 1972 rose by 13% to $722 million from the 1971 value of $642 million. The trends in corresponding quantities were less consistent. Thousand-unit counts for unglazed facing tile, floor and wall tile, building bricks, and the tonnage of vitrified sewer pipe increased 33%, 12%, and 11% respectively, over that shipped in 1971. Shipments in 1972 of unglazed structural tile, glazed facing tile and the tonnage of vitrified sewer pipe showed decreases of 34%, 15%, and less than ½% respectively, compared with shipments in 1971.

Lightweight Aggregate.—Consumption of clay and shale in the making of lightweight aggregate increased in 1972 to an alltime high of 10,750,217 short tons. This was a 5% increase over the 10.2 million short tons used in 1971.

The tonnage of raw material mentioned in tables 16 and 19 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 1972, a total 1,269,646 short tons of slate was expanded for lightweight aggregate, an increase of 54% over the 1971 figure of 824,787 tons. In addition, the National Slag Association reported the amount of slag used as lightweight concrete aggregate and in block manufacture decreased 8% in 1972 from 1,377,000 short tons in 1971 to 1,264,000 tons.

Refractories.—All types of clay were used in manufacturing refractories. Fire clay and kaolin accounted for 85% and 12%, respectively, of the total clays used for this purpose. Minor tonnages of ball clay (2%) and bentonite, fuller's earth, and common clay and shale (the remaining 1%), were also used, primarily as bonding agents.

The tonnage used for refractories in 1972 increased from 6% in 1971 to 7% of the total clays produced. This slight increase in the use of clay-based refractories reverses a downward pattern set for a number of years. The increase was due primarily to an upsurge in the production of refractory aggregates which offset the continuing decline in the production of more conventional brick-type refractories. Refractory aggregates are used mostly in plastic, ramming, and castable mixes.

Filler.—All clays are used to some extent as fillers in one or more areas of use. Kaolin and fuller's earth 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. The other important filler clay, fuller's earth, was used primarily in pesticides and fertilizers. Clays in pesticides and fertilizers are used either as carriers, diluents, or prilling agents.

A total of 5% of the clay produced in 1972 was used in filler applications. Kaolin accounted for 92% and fuller's earth for 6% of all the clay used for these purposes. The other clays accounted for the remaining 2%. The consumption of kaolin, except for plastics which decreased 10%, increased in the amount used, ranging from less than 1% to 90%. Kaolin used in paper filling and coating increased less than 1%, in paint 16%, in fertilizer 30%, in rubber 40%, and in pesticides 90%. Total quantity of fuller's earth used in insecticides and fungicides decreased 20%.

Absorbent Uses.—Absorbent uses for clays, approximately 586,296 short tons, consumed slightly less than 1% of the total 1972 clay production. Demand for absorbents in 1972 decreased 8% from that reported for 1971. Fuller's earth was the principal clay used in absorbent applications; bentonite was used to a lesser degree. Fifty-nine percent of the entire fuller's earth output was consumed for these purposes. Demand for clays in animal litter, representing 41% of the 1972 absorbent demand, decreased 14% from that reported for 1971. Demand for use in floor absorbents, chiefly to absorb hazardous oily substances, represented the remaining 59% of absorbent demand and decreased 3% from the 1971 figure.

Drilling Mud.—Demand for clays in rotary-drilling fluids increased 4% in 1972 from 583,712 short tons used in 1971 to approximately 596,180 tons. Drillings muds consumed slightly less than 1% of the entire 1972 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 total amount of clay used for this purpose. Small amounts of kaolin, ball clay, and common clay and shale were used in specialized formulations.

Floor and Wall Tile.—Common clay and shale, ball clay, kaolin, and fire clay, 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 1972. Demand in 1972, 452,014 short tons, decreased over 7% from that shown in 1971.

Pelletizing Iron Ore.—Bentonite is used as a binder in forming iron ore pellets prior to the blast furnace operation. Demand, reversing a general trend for several years, decreased 9% in 1972, to 707,187 short tons. This decline in the use of bentonite for iron ore pelletizing reflects the inroads made by the lower cost Greek bentonites into a traditional U.S. clay market. Of the total bentonite produced in 1972, about 26% of the swelling variety (a decrease from the 37% in 1971) 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, and related products, excluding clay flower pots, accounted for 1% of the total 1972 clay output. The total clay demand, principally ball and kaolin clays, rose about 4% from 591,167 short tons in 1971 to 616,494 short tons in 1972.

Table 16.—Clays sold or used as reported by producers in the United States in 1972, 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	--	(2)	--	--	(2)	73,417	--	[3] 73,417
Alum (aluminum sulfate) and other chemicals	--	(4)	--	(4)	(4)	111,005	24,463	135,468
Animal feed	--	100,590	--	--	(2)	9,452	--	[3] 110,042
Animal litter	--	3,682	--	--	238,921	--	--	242,603
Asphalt emulsion and tiles	(4)	(4)	--	--	--	--	11,110	11,110
Brakes and clutches	--	--	874	--	--	--	--	874
Building brick:								
Common	--	(2)	3,607,901	--	--	(2)	--	[3] 3,607,901
Face	--	(2)	16,575,310	30,000	--	285,268	--	[3] 16,890,578
Catalysts (oil refining)	150	(4)	--	--	(4)	67,990	3,406	71,546
Cement, portland	--	(2)	12,539,953	--	(2)	75,698	--	[3] 12,615,651
Ceramic—hobby	--	--	1,221	--	--	5	--	1,226
China/dinnerware	(2)	--	--	--	--	50,801	--	[3] 50,801
Crockery and other earthenware	(4)	--	5,118	(4)	--	19,995	9,484	34,597
Drilling mud	(2)	537,357	200	--	58,623	(2)	--	[3] 596,180
Electrical porcelain	(2)	--	--	--	--	5,938	--	[3] 5,938
Fertilizers	--	2,608	(2)	--	42,006	75,969	--	[3] 120,583
Fiberglass	--	--	--	--	--	153,788	--	153,788
Filtering, clarifying, and decolorizing:								
Animal oil	--	(4)	--	--	(4)	--	31,742	31,742
Mineral oil	--	51,240	--	--	37,984	--	--	89,224
Vegetable oil	--	74,556	--	--	(2)	--	--	[3] 74,556
Firebrick, block, and shapes	40,851	6,596	--	2,231,914	--	337,347	--	2,616,708
Floor absorbents	--	(2)	--	--	343,693	--	--	[3] 343,693
Flower pots	--	--	48,098	--	--	--	--	48,098
Flue linings	--	--	144,482	(4)	--	(4)	62,425	206,907
Foundry sand	--	711,534	--	273,900	--	(2)	--	[3] 985,434
Glazes, glass, and enamels	1,555	(2)	--	(2)	--	27,126	--	[3] 28,681
Grogs and crudes, refractory	--	--	--	244,035	--	153,541	--	397,576
Gypsum products	--	--	--	--	--	16,101	--	16,101
High-alumina (minimum 50% Al_2O_3) refractories	(2)	--	--	223,487	--	(2)	--	[3] 223,487
Kiln furniture	(4)	--	--	(4)	--	--	22,543	22,543
Lightweight aggregate	--	--	10,750,217	--	--	--	--	10,750,217
Linoleum	--	--	874	--	--	(2)	--	[3] 874
Medical, pharmaceutical, and cosmetic	--	(4)	--	--	(4)	(4)	2,734	2,734
Mortar and cement, refractory	(4)	--	(4)	257,553	(4)	(4)	58,582	316,135
Paint	--	(4)	96	--	(4)	141,495	3,419	145,010
Paper coating	--	(2)	--	--	(2)	1,433,916	--	[3] 1,433,916
Paper filling	(2)	--	--	--	(2)	765,138	--	[3] 765,138
Pelletizing (iron ore)	--	707,187	--	--	--	--	--	707,187
Pesticides and related products	(2)	40,208	--	--	144,380	28,442	--	[3] 213,030
Plastics	--	--	(2)	--	(2)	71,844	--	[3] 71,844
Plug, tap, and wad	--	--	--	7,499	--	--	--	7,499
Pottery	182,471	(4)	13,267	(4)	--	23,743	12,152	231,633
Rubber	(2)	--	--	--	(2)	376,099	--	[3] 376,099
Sanitary ware	173,431	--	--	--	--	146,053	--	319,484
Sewer pipe, vitrified	--	--	1,828,830	183,557	--	--	--	2,012,387
Tile:								
Drain	--	--	410,684	--	--	--	--	410,684
Floor and wall, ceramic	137,772	--	141,588	4,000	(2)	43,435	--	[3] 326,795
Quarry	(2)	--	125,219	--	--	--	--	[3] 125,219
Roofing	--	--	52,544	--	--	(2)	--	[3] 52,544
Structural	--	--	132,148	--	--	--	--	132,148
Other	--	--	32,223	--	--	--	--	32,223
Waterproofing and sealing	--	39,350	--	--	(2)	--	--	[3] 39,350
Miscellaneous [5]	36,880	27,286	12,376	4,174	75,935	66,880	--	223,531
Undistributed	66,490	41,710	24,000	92,925	7,876	9,059	--	--
Exports	35,685	423,094	40,370	27,591	39,120	748,092	--	1,313,952
Total	675,285	2,766,998	46,487,593	3,580,635	988,538	5,317,637	(6)	59,816,686

[1] Total of clays indicated by footnote 4.
[2] Withheld to avoid disclosing individual company confidential data; included with "Miscellaneous."
[3] Incomplete figure; remainder included with "Miscellaneous."
[4] Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[5] Includes graphite anodes; caulking, putty, sealers, glue; dummy and oil well sealing; ink; mineral wool and insulation; roofing granules; textiles; water treatment and filtering; unknown uses; and data indicated by footnotes 2 and 3.
[6] Total "Undistributed" included with totals for each specific use.

Table 17.—Shipments of principal structural clay products in the United States

Products	1968	1969	1970	1971	1972
Unglazed brick (building) 1,000 standard brick	7,556,809	7,289,669	6,495,995	7,569,726	8,402,217
Value thousands	$318,365	$318,892	$287,131	$346,390	$403,774
Unglazed structural tile short tons	191,067	241,509	181,046	r 152,536	100,534
Value thousands	$4,169	$6,875	$5,903	$4,432	$3,084
Vitrified clay sewer pipe and fittings short tons	1,705,528	1,783,546	1,622,339	1,720,597	1,717,991
Value thousands	$109,465	$120,420	$119,048	$133,067	$143,082
Facing tile, ceramic glazed, including glazed brick 1,000-brick equivalent	211,223	200,074	167,070	152,536	129,498
Value	$19,708	$19,188	$15,661	$14,904	$12,934
Facing tile, unglazed and salt glazed, 1,000-tile equivalent, 8- by 5- by 12-inch	3,032	2,965	1,915	950	1,262
Value thousands	$750	$729	$469	$129	$257
Clay floor and wall tile and accessories, including quarry tile 1,000 square feet	274,512	284,780	250,405	276,112	307,894
Value thousands	$138,319	$142,878	$126,219	$142,645	$159,105
Total value thousands	$590,776	$608,982	$554,431	$641,567	$722,236

r Revised.

Table 18.—Clay and shale used in building brick production in the United States in 1972, by State

State	Short tons	Value	State	Short tons	Value
Alabama	1,114,432	$1,766,607	Mississippi	990,075	$1,233,164
Arizona	93,957	59,941	Missouri	230,269	486,638
Arkansas	456,870	422,027	Nebraska	44,999	51,420
California	391,645	787,005	New Hampshire	50,750	70,060
Colorado	387,415	755,685	New Jersey	110,371	379,810
Connecticut	149,223	277,989	New Mexico, South Dakota, and Utah	166,280	342,568
Delaware	15,480	9,288	New York	280,680	583,570
Georgia	1,493,763	2,156,710	North Carolina	2,875,922	3,209,062
Hawaii and Florida	32,122	45,475	North Dakota	14,580	13,122
Idaho and Massachusetts	165,914	297,515	Ohio	1,388,373	2,867,990
Illinois	522,399	1,057,213	Oklahoma	275,477	411,346
Indiana	627,854	1,022,103	Oregon	39,543	60,708
Iowa	282,106	685,484	Pennsylvania	1,437,206	4,704,502
Kansas	398,989	549,706	South Carolina	1,287,437	1,933,767
Kentucky	295,467	344,794	Tennessee	726,934	583,827
Louisiana	215,102	338,117	Texas	1,592,148	3,112,617
Maine	40,196	56,986	Virginia	1,056,852	1,208,750
Maryland	462,370	1,138,648	Washington	121,614	250,625
Michigan and Montana	113,872	156,128	West Virginia	126,372	182,120
Minnesota	50,177	75,266	Wisconsin	3,081	5,546
			Wyoming	54,895	132,488
			Total	20,183,211	33,826,387

Table 19.—Clay and shale used in lightweight aggregate production in the United States in 1972, by State and including Puerto Rico

State	Short tons	Value
Alabama and Colorado	884,136	$1,036,413
Arkansas, Florida, and Nebraska	502,500	574,000
California	958,097	2,477,561
Illinois and Iowa	1,000,646	1,514,451
Indiana	288,822	502,550
Kansas, Kentucky, and Maryland	881,680	1,196,729
Louisiana and Massachusetts	381,630	612,994
Michigan and Missouri	523,653	1,767,862
Minnesota and Montana	139,880	213,040
Mississippi	476,033	238,017
New York	1,010,094	1,021,031
North Carolina, Ohio, and South Dakota	1,025,541	1,033,177
North Dakota and Utah	162,833	412,161
Oklahoma	216,663	325,000
Oregon	45,000	90,000
Pennsylvania	72,500	39,875
Tennessee	338,394	321,900
Texas	1,492,976	2,092,200
Virginia and Washington	313,139	298,081
Puerto Rico	36,000	36,000
Total	10,750,217	15,803,042

Table 20.—Shipments of refractories in the United States, by kind

Product	Unit of quantity	Shipments 1971 Quantity	Shipments 1971 Value (thousands)	Shipments 1972 Quantity	Shipments 1972 Value (thousands)
CLAY REFRACTORIES					
Fire clay (including semisilica) brick and shapes except superduty.	1,000 9-inch equivalent	209,900	$46,916	214,475	$49,960
Superduty fire clay brick and shapes	do	60,930	22,060	67,826	24,930
High-alumina brick and shapes (50% Al_2O_3 and over) made substantially of calcined diaspore or bauxite.[1]	do	61,872	39,244	74,620	51,524
Insulating firebrick and shapes	do	41,452	13,320	44,684	14,824
Ladle brick	do	178,883	26,550	194,874	30,579
Sleeves, nozzles, runner brick, and tuyeres	do	53,510	14,743	47,265	15,979
Glasshouse pots, tank blocks, feeder parts, and upper structure shapes used only for glass tanks.[1 2]					
Hot-top refractories	Short tons	23,261	1,914	25,796	2,092
Clay-kiln furniture, radiant-heater elements, potters' supplies, and other miscellaneous shaped refractory items.	do	NA	9,686	NA	11,883
Refractory bonding mortars, air-setting (wet and dry types) [3]	Short tons	62,408	9,675	67,019	11,263
Refractory bonding mortars, except air-setting types.[3]	do	8,817	1,162	8,632	1,262
Plastic refractories and ramming mixes [3]	do	159,648	15,196	174,403	18,162
Castable refractories (hydraulic-setting)	do	173,068	20,733	192,624	24,528
Insulating castable refractories (hydraulic-setting).	do	42,716	6,510	44,642	7,647
Other clay refractory materials sold in lump or ground form.[4 5]	do	310,294	8,854	368,660	10,046
Total clay refractories		XX	236,563	XX	274,679
NONCLAY REFRACTORIES					
Silica brick and shapes	1,000 9-inch equivalent	33,637	12,147	32,437	12,877
Magnesite and magnesite-chrome brick and shapes (magnesite predominating) (excluding molten-cast and fused magnesia).	do	77,039	93,572	90,109	106,726
Chrome and chrome-magnesite brick and shapes (chrome predominating) (excluding molten-cast).	do	15,153	16,703	18,713	20,044
Graphite crucibles, retorts, stopper heads, and other shaped refractories containing natural graphite.	Short tons	14,823	14,323	15,756	15,759

See footnotes at end of table.

Table 20.—Shipments of refractories in the United States, by kind—Continued

Product	Unit of quantity	Shipments 1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
NONCLAY REFRACTORIES—Continued					
Mullite brick and shapes made predominantly of kyanite, sillimanite, andalusite, or synthetic mullite (excluding molten-cast).	1,000 9-inch equivalent	5,839	9,821	4,517	8,917
Extra-high-alumina brick and shapes made predominantly of fused bauxite, fused or dense-sintered alumina (excluding molten-cast).	----do------	3,006	9,299	2,684	8,629
Silicon carbide brick and shapes made predominantly of silicon carbide (including kiln furniture).	----do------	3,410	13,472	3,355	13,347
Zircon and zirconia brick and shapes made predominantly of either of these materials.	----do------	1,953	6,914	1,785	6,571
Forsterite, pyrophyllite, molten-cast, dolomite, dolomite-magnesite, and other nonclay brick and shapes including carbon refractories except those containing natural graphite.	----do------	27,281	48,202	35,216	65,270
Mortars:					
Basic bonding mortars (magnesite or chrome ore predominating).	Short tons---	94,774	9,782	11,465	1,355
Other nonclay refractory mortars---------	----do------	30,347	6,097	29,856	5,995
Nonclay refractory castables (hydraulic-setting).	----do------	40,995	10,235	49,416	12,861
Plastic refractories and ramming mixes (wet and dry types):					
Basic (magnesite, dolomite, or chrome ore predominating).	----do------	121,214	17,822	128,550	18,371
Other nonclay plastic refractories and ramming mixes.	----do------	73,883	16,370	80,884	19,394
Dead-burned magnesia or magnesite----------	----do------	102,270	8,511	115,164	10,075
Nonclay gunning mixes--------------------	----do------	193,667	25,973	303,108	35,817
Other nonclay refractory materials sold in lump or ground form.[4]	----do------	213,676	7,993	342,587	11,620
Total nonclay refractories-------------		XX	327,236	XX	373,628
Grand total refractories--------------		XX	563,799	XX	648,307

NA Not available. XX Not applicable.

[1] Excludes data for mullite and extra-high-alumina refractories. These products are included with mullite and extra-high-alumina brick and shapes in the nonclay refractories section.

[2] Now included with fire clay (including semisilica) brick and shapes, except superduty.

[3] Includes data for bonding mortars which contain up to 60% Al_2O_3, dry basis. Bonding mortars which contain more than 60% Al_2O_3, dry basis, are included in the nonclay refractories section.

[4] Represents only shipments by establishments classified in "manufacturing" industries, and excludes shipments to refractories producers for the manufacture of brick and other refractories.

[5] Includes data for calcined clay, ground brick, and siliceous and other gunning mixes.

Table 21.—U.S. exports of clays, by country and class in 1972

(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
Australia	49	1,199	1	21	1	32	12	338	--	--	12	570	75	2,160
Brazil	7	275	1	59	1	64	3	268	1	47	6	414	19	1,127
Canada	293	5,389	49	640	8	444	149	4,826	42	822	100	2,958	641	15,079
Chile	1	34	1	94	(1)	2	(1)	18	(1)	1	(1)	22	2	171
Colombia	2	119	--	--	(1)	1	4	127	--	--	1	38	7	285
France	3	205	1	46	2	222	13	578	--	--	24	1,292	43	2,343
Germany, West	34	1,088	6	223	2	74	122	4,791	--	--	14	639	178	6,810
Indonesia	13	435	--	--	--	--	(1)	1	--	--	1	62	14	498
Italy	1	126	2	189	1	63	83	3,230	(1)	1	63	3,275	150	6,884
Japan	7	697	7	416	(1)	16	159	7,524	(1)	18	70	2,983	243	11,654
Mexico	1	77	47	706	(1)	2	29	1,112	38	633	13	253	128	2,783
Netherlands	14	384	2	113	3	117	38	1,114	(1)	1	24	1,002	81	2,731
Philippines	(1)	74	(1)	30	--	--	1	62	3	86	6	398	10	650
Singapore	29	1,385	--	--	(1)	1	(1)	3	(1)	3	3	148	32	1,540
South Africa, Republic of	2	216	(1)	3	(1)	3	1	121	(1)	4	3	230	6	577
Sweden	(1)	58	(1)	3	(1)	7	9	392	(1)	2	2	86	11	548
Taiwan	(1)	60	(1)	1	--	--	(1)	28	(1)	2	12	604	12	695
United Kingdom	29	1,097	2	127	10	301	17	390	(1)	4	12	601	70	2,520
Venezuela	9	362	1	31	1	64	10	507	1	30	2	99	24	1,093
Other	27	1,838	4	203	10	315	18	902	2	35	40	2,775	101	6,068
Total	521	15,113	124	2,905	39	1,728	668	26,332	87	1,689	408	18,449	1,847	66,216

[1] Less than ½ unit.

Table 22.—U.S. imports for consumption of clay in 1972

Kind	Quantity (short tons)	Value (thousands)
China clay or kaolin, whether or not beneficiated:		
Brazil	75	$1
Canada	701	44
Germany, West	1	1
Japan	134	29
United Kingdom	24,570	661
Total	25,481	736
Fuller's earth: United Kingdom	43	3
Bentonite: Italy	127	8
Common blue and other ball clay, not beneficiated: United Kingdom	6,916	112
Common blue or other ball clay, wholly or partly beneficiated:		
Canada	15	2
United Kingdom	2,803	97
Total	2,818	99
Clays, n.e.c., not beneficiated:		
Bahamas	27,328	21
Canada	77	1
France	3	(1)
Germany, West	45	4
Total	27,453	26
Clays, n.e.c., wholly or partly beneficiated:		
Australia	1	(1)
Canada	32	4
Germany, West	239	21
Japan	142	34
United Kingdom	736	45
Total	1,150	104
Clays artificially activated with acid:		
Canada	1,351	67
Germany, West	305	30
Ireland	(1)	(1)
Japan	276	63
Mexico	794	60
United Kingdom	(1)	1
Total	2,726	221
Grand total	66,714	1,309

[1] Less than ½ unit.

WORLD REVIEW

Australia.—The Australian Mineral Development Laboratories at Frewville, South Australia, was requesting quarrying and mining companies in the Sydney and Melbourne areas to submit samples of clay, shale, or potentially bloating material for a preliminary evaluation of bloating behavior up to 1,350° C. These evaluations were part of the Laboratories' investigations throughout Australia for new sources of lightweight aggregate material capable of being used in heavy construction. The Laboratories were also planning tests to develop brick and tile blends using lightweight sands and fines.[2]

Abaleen Minerals NL reported plans to begin kaolin production early in 1973, from its undisclosed southern deposit. Preliminary geological studies of the deposit proved some 20 million tons of exploitable

[2] Industrial Minerals. No. 62, November 1972, p. 29.

Table 23.—Kaolin: World production, by country
(Thousand short tons)

Country [1]	1970	1971	1972 [p]
North America:			
Mexico	87	80	79
United States [2]	4,926	4,886	5,318
South America:			
Argentina	82	70	61
Chile	53	46	60
Columbia	102	106	111
Ecuador	1	[e] 1	[e] 1
Paraguay	1	1	4
Peru	2	[e] 2	[e] 2
Europe:			
Austria (marketable)	108	102	97
Belgium [e]	110	110	110
Bulgaria	140	152	[e] 165
Czechoslovakia	405	445	[e] 468
Denmark [e]	20	20	20
France [3]	575	[e] 580	[e] 580
Germany, West (marketable)	493	460	460
Greece	53	59	[e] 61
Hungary	79	[e] 80	[e] 80
Italy:			
Crude	[r] 111	106	76
Kaolinitic earth	11	16	[e] 22
Portugal	58	50	41
Romania [e]	55	55	55
Spain (marketable) [4]	192	357	[e] 390
Sweden [e]	33	33	33
U.S.S.R. [e]	2,000	2,100	2,200
United Kingdom	3,509	3,054	3,371
Africa:			
Angola	2	1	[e] 1
Egypt, Arab Republic of	25	49	[e] 55
Ethiopia	12	11	29
Kenya	2	[e] 2	1
Malagasy Republic	1	2	2
Mozambique	2	2	2
Nigeria	1	(5)	--
South Africa, Republic of	41	43	42
Swaziland	2	2	2
Tanzania	1	1	[e] 1
Asia:			
Hong Kong	4	3	3
India:			
Salable crude	225	203	240
Processed	109	107	127
Indonesia (kaolin powder)	10	11	7
Iran [6]	50	53	[e] 55
Israel	--	22	32
Japan	243	420	356
Korea, Republic of	215	211	203
Malaysia	4	13	116
Pakistan	10	3	5
Sri Lanka	2	3	4
Taiwan [7]	[e] 11	[e] 1	18
Thailand	1	11	[e] 12
Vietnam, South [e]	1	1	1
Oceania:			
Australia [8]	99	[e] 100	[e] 100
New Zealand	13	22	10
Total	[r] 14,292	14,268	15,289

[e] Estimate. [p] Preliminary. [r] Revised.
[1] In addition to the countries listed, Brazil, People's Republic of China, East Germany, Lebanon, Southern Rhodesia, and Yugoslavia also produced kaolin, but information is inadequate to make reliable estimates of output levels. Morocco produced less than 500 tons in each of the years covered by this table.
[2] Kaolin sold or used by producers.
[3] Includes kaolinite clay.
[4] Figure apparently represents marketed output, including some crude kaolin and some washed kaolin.
[5] Less than ½ unit.
[6] Year beginning March 21 of that stated.
[7] Data given are for ceramic and pottery and paper filler clays.
[8] Includes ball clay.

ore, but indications were that this figure could be much higher. Although the kaolin has a high titanium content, which tends to stain paper, Abaleen planned to sell to the papermakers.[3]

Ataka and Co. Ltd., Japan, announced plans to expand its kaolin mining and processing project at Greenbushes, Western Australia, 135 miles south of Perth. Expansion of the Greenbushes pilot plant will increase production to 3,000 tons per month, at a cost of $1.5 million.[4]

Mineral Deposits Ltd. reported conducting feasibility studies on bentonitic clays from several localities with Baroid Australia Pty. Ltd., an associated company.[5] The Steetley Company, Ltd., acquired Commercial Minerals Pty. Ltd. of Newcastle, New South Wales. Commercial Minerals, among its activities, extracted and produced calcined flint clay, used widely as a refractory. This latest acquisition by Steetley, a vertically integrated United Kingdom refractory producer, continued the groups' diversification and complements its basic refractory products.[6]

English China Clay, Ltd., put a new kaolin processing plant on stream in Victoria. The new plant's annual capacity of 36,000 short tons per year of wet processed products was slated for expansion within the next few years to 90,000 short tons per year.[7]

Canada.—A decision in midyear 1973 was expected on a joint venture between Algoma Central and an unnamed firm to exploit Algoma's 200-million-ton silica-kaolin deposits 50 miles north of Hearst, Ontario. Algoma and its partner, experienced in kaolin mining, processing, and marketing, were planning milling at a rate of 600,000 tons per year to yield 80% silica, 15% kaolin, and 5% waste. The kaolin would be upgraded to about 83% brightness by a process developed jointly with the Ontario Research Foundation for use in papermaking.[8]

Egypt, Arab Republic of.—A joint scientific program was announced between Egypt and Czechoslovakia to develop the

[3] Page 26 of work cited in footnote 2.
Mining Journal (London). V. 278, No. 7139, June 16, 1972, p. 500.
[4] Pit and Quarry. V. 65, No. 2, August 1972, p. 20.
[5] Industrial Minerals. No. 57, June 1972, p. 53.
[6] Industrial Minerals. No. 61, October 1972, p. 33.
[7] Colligan, R. V. Kaolin. Eng. and Min. J., v. 174, No. 3, March 1973, pp. 158–159.
[8] Engineering and Mining Journal. V. 173, No. 10, October 1972, p. 24.

Table 24.—Bentonite: World production, by country

(Short tons)

Country [1]	1970	1971	1972 [p]
North America:			
Guatemala	2,316	--	--
Mexico	69,390	63,524	41,870
United States	2,532,843	2,665,757	2,766,995
South America:			
Argentina	61,178	94,764	[e] 99,000
Peru	39,218	[e] 40,000	[e] 40,000
Europe:			
France	21,315	[e] 22,000	22,000
Greece	207,981	245,500	[e] 254,000
Hungary	71,650	78,264	[e] 77,000
Italy	353,683	327,102	301,153
Poland	55,116	[e] 55,000	[e] 55,000
Romania	132,277	[e] 132,000	[e] 132,000
Spain	41,176	42,167	[e] 43,000
Africa:			
Algeria (bentonite clay)	[e] 22,000	10,490	21,947
Kenya	62	[e] 28	--
Morocco	[e] 23,000	19,901	26,608
Mozambique	6,055	6,009	2,637
South Africa, Republic of	18,412	22,745	26,799
Asia:			
Burma	--	--	1,439
Cyprus (bentonite clay)	14,441	13,849	12,174
Iran	13,228	14,330	[e] 15,000
Pakistan	--	432	530
Philippines	181	171	67
Turkey [e]	2,200	2,200	2,200
Israel (metabentonite)	--	2,756	2,205
Oceania:			
Australia: [2] [3]			
Bentonite	128	101	[e] 110
Bentonitic clay	282	273	[e] 260
New Zealand	21,740	12,964	683
Total	3,709,872	3,892,327	3,944,677

[e] Estimate. [p] Preliminary.
[1] In addition to the countries listed Austria, Canada, the People's Republic of China, 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] Data represent exports of bentonite clay.
[3] Data are for year ending June 30 of that indicated.

Table 25.—Fuller's earth: Noncommunist world production, by country

(Short tons)

Country [1]	1970	1971	1972 [p]
Algeria	66,139	[e] 66,000	[e] 66,000
Argentina	3,616	1,033	[e] 992
Australia [2]	--	90	99
Italy	79,956	82,626	82,662
Mexico	26,673	22,316	33,501
Morocco	12,527	15,711	17,017
Pakistan	[e] 14,000	14,106	12,397
Senegal (Attapulgite)	3,362	3,097	3,405
South Africa, Republic of	1,713	1,347	2,091
United States	981,890	1,013,914	988,538
Total	1,189,876	1,220,240	1,206,702

[e] Estimate. [p] Preliminary.
[1] In addition to the countries listed, France, Iran, Japan, Turkey, and the United Kingdom 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 a reliable estimate of output levels. Similarly, no information is available on output in the Communist nations of Europe and Asia, but at least some of them also are presumably producing fuller's earth.
[2] Data are for year ending June 30 of that stated.

newly discovered bentonite deposits in Fayyum for use in oil well drilling.

France.—Installation of additional equipment at Engelhard Minerals & Chemical Corp. and Solvay's jointly owned kaolin facility in Brittany was nearing completion. The additional equipment was designed to upgrade the plant production to paper-coating quality. Plant capacity was estimated at 110,000 short tons per year.[9]

Germany, West.—Sued-Chemie A.G. and Girdler-Suedchemie G.m.b.H. of Munich announced that their recently appointed agents for bleaching earths and catalysts, Production Chemicals (Rochdale) Ltd., United Kingdom, will provide detailed technical services.[10]

Guyana.—Final arrangements were made with a participating Japanese company, Nisho-Iwa Co., for erecting a kaolin proc-

[9] Work cited in footnote 7.
[10] Industrial Minerals. No. 55, April 1972, p. 42.

essing plant. The entire planned production was scheduled for export to Japan.

India.—The Government, in response to disappointing performances by selected industries, proposed establishing a holding company to control future development of the steel, coking, coal, and refractories industries.

Indonesia.—China clay mined at Togaret, Minahasa Regency, in Sulawesi, by P. T. Usis in partnership with Kanematsu Cosho, Ltd., was exported entirely to Japan. China clay recovered from the other kaolin deposits, Bangka and Belitung Islands, was used by the principal domestic consumer, P. T. Keramika Indonesia Asosiasi.

Italy.—A permit to exploit Sardinian bentonite deposits was granted to C. Laviosa S.p.A. of Leghorn. Laviosa was also planning to build a plant at San Antioco on a 7 acre site. Annual production of bentonite was expected to amount to 200,000 tons. Sud Chemie Italia S.p.A. released plans for producing activated bentonite locally from Sardinian clays in a plant to be built by Breda Progetti e Costruzioni.[11]

Ivory Coast.—The Government was considering plans for erecting a plant 30 miles from Abidjan near a large clay deposit at Plinhim on the Comeo River, capable of producing 260,000 cubic yards of lightweight aggregate per year. The Ceram-Anten Co. announced plans for constructing a second facility in Abidjan for manufacturing mosaic and enameled ceramics. The second facility would enable Ceram-Anten to treble tile production to 3,500,000 square feet. A new factory for producing sanitary fixtures, dishes, and faience tiles was also scheduled. The new factory was to be located adjacent to a large deposit said to contain an estimated 4,500,000 cubic yards of white fire clay, 10 miles northeast of Abidjan.[12]

Malaysia.—The Japanese Sanyo Paper and Pulp Co. kaolin operations were started up during the year. The new operation reportedly increased Malaysian kaolin production significantly.[13]

Pakistan.—West Pakistan Industrial Development Corp. was setting up its china clay processing plant at Shahderi in Swat. The plant scheduled for completion in early 1973 was reported to be capable of producing nearly 5,000 tons of water-washed clay annually.[14] Pakpor Ceramics of Lala Musa has acquired licenses to import undisclosed quantitites of ceramic-grade china clay.[15]

South Africa, Republic of.—A deposit of "potentially high-grade" china clay has been discovered on a farm in the Cato Ridge area, between Durban and Pietermaritzburg. The Johannesburg Consolidated Investment Corp. has been contracted with for mining the clay.[16]

Sri Lanka.—A geological survey conducted by the Sri Lanka Ceramic Corp. succeeded in locating nearly 350,000 tons of kaolin in 10 acres of land near Bolgoda. The corporation was negotiating with Japanese firms who were interested in setting up a local ceramic factory, exclusively for export production.

A market survey conducted earlier by the corporation disclosed a large potential market, particularly in the Middle East, for the corporation's "batik" designed ceramics.[17]

Surinam.—The kaolin underlying the large bauxite deposits of the eastern coastal plain near Onverdacht and Moengo was reported to be suitable for papermaking. Higher quality kaolin deposits were unfortunately associated with a few weathered pegmatites.[18]

Thailand.—Kaolin production continued to increase dramatically. Production in 1972, nearly 12,000 short tons, represented a fourfold increase over that produced in 1970. Exports to Japan accounted for most of the increased production.[19]

Turkey.—A newly formed company, Kaolin Ticaret ve Sanayii, A.S., was planning to set up facilities to exploit a kaolin deposit in Eskişehir. Most of the kaolin production was intended for ceramic manufacture in domestic and overseas markets.[20]

---

[11] Industrial Minerals. No. 53, February 1973, p. 35.
[12] Translations on Africa, No. 302, Joint Publications Research Service (JPRS) L/4256, Aug. 28, 1972, p. 24.
[13] Industrial Minerals. No. 59, August 1972, p. 44.
[14] Mining Journal (London). V. 279, No. 7158, Oct. 27, 1972, p. 337.
[15] Industrial Minerals. No. 58, July 1972, p. 37.
[16] Mining Journal (London). V. 278, No. 7124, Mar. 3, 1972, p. 176.
[17] Mining Journal (London). V. 278, No. 7139, June 16, 1972, p. 499.
[18] Geologisch Mijnbouw Kundige Dienst, Paramaribo, Surinam. 30 years Geological and Mining Service of Surinam. 1973, pp. 21–22.
[19] U.S. Bureau of Mines. Mineral Trade Notes, V. 69, No. 7, July 1972, p. 18.
[20] Industrial Minerals. No. 54, March 1972, p. 36.

Samas Sanayii Madenleri, A.S., a Turkish company, was awaiting financial backing to exploit a bentonite deposit near Reşadiye, Tokat, in northeastern Turkey. A proposed plant, pending negotiations with knowledgeable U.S. companies for supplying the needed processing equipment and expertise, was scheduled to produce between 30,000 and 40,000 tons of Wyoming-type swelling sodium bentonite annually. The proposed Reşadiye plant would include the usual drying, grinding, and packing facilities. Most of the plant's output was intended for export to European and Middle Eastern oil producing regions. The deposit, delineated nearly 5 years ago, was estimated to contain over 15 million tons of clay reserves in the present areas alone.[21]

United Kingdom.—Hepworth Ceramic Holdings, Ltd., acquired both Joe Kitson and Sons (Minerals) Ltd., and Thomas Temperley and Son, Ltd. Kitson has extensive clay-bearing land at Denby Dale in Yorkshire, which is near their main pipe-making works. Temperley manufactures and markets sanitary pipes and fittings and is based at Bacup, Lancashire.[22]

The Cawoods Refractories, Ltd., plant at Belvedere in Kent was being enlarged to meet the increasing demand for the firm's high-purity refractory aggregates. The new facility was scheduled to be on stream by the end of 1973.[23]

Watts, Blake, Bearne and Co., Ltd., (WBB) continued expansion of its ball clay production and raw materials handling capabilities. Development of their Courtmoor pit, North Devon, was well advanced, and increased production was planned for 1973. The firm's Cornwood New Plant for china clays was completed and capacity was increased by at least 50%. The new plant facilities include an automatic pressroom, band dryers, thickeners and automatically fed wet and dry storage areas. The dry storage bunkers have a 12,000-ton capacity.[24]

Agreement has been reached between Steetley Co. and NL Industries, Inc. (U.S.) on their joint bentonite derivatives operations. This joint venture by Steetley complements its newly acquired interest in the German bentonite firm, Bentone Chemie G.m.b.H., near Bremerhaven.[25]

The application of English Clays Lovering Pochin and Co., Ltd. (ECLP) to extend its 140-year-old clayworks on the southern edge of Dartmoor National Park continued in abeyance. This particular expansion has aroused considerable local opposition. ECLP's planning for many decades hung upon this Dartmoor extension.[26]

U.S.S.R.—Reports of a wet kaolin processing facility, using Japanese technology, of unknown capacity, location, and quality, continued to circulate throughout the industry.

TECHNOLOGY

Concomitant production of metallurgical-grade alumina and portland cement clinker from kaolin-type clays by a lime sintering technique was described in a patent.[27] Initially kaolin is admixed with sufficient limestone to form base soluble calcium monoaluminate and insoluble calcium disilicate during lime sintering. Aluminum trihydrate is precipatated from the digested sinter solution by carbonating. The precipitate is subsequently calcined to the desired alumina. The insoluble calcium disilicate solid residue, from the digestion step, is mixed with sufficient limestone and fired to form a low aluminate containing portland cement clinker. Another patent covering a method applicable to producing alumina from clays by a combined reducing then calcining approach was issued.[28] The method involves reducing an alumino silicate ore and a potassium sulfate-bearing ore, such as polyhalite and langbeinite, and then calcining the reductants to form base soluble potassium aluminate and insoluble silicates. The reducing step reaction successfully decomposes the reactants and produces H_2S. The aluminate is separated from the insoluble silicates KOH and/or K_2CO_3 solution and precipitated as $Al(OH)_3$ with

[21] Page 21 of work cited in footnote 20.
[22] Work cited in footnote 10.
[23] Pages 33 and 34 of work cited in footnote 5.
[24] Page 29 of work cited in footnote 15.
[25] Page 48 of work cited in footnote 6.
[26] Pages 21 and 22 of work cited in footnote 20.
[27] Angstadt, R. L., and R. N. Bell (assigned to Stauffer Chemical Co.). Production of Alumina and Portland Cement From Clay and Limestone. U.S. Pat. 3,642,437, Feb. 15, 1972.
[28] Burk, N., W. M. Bowes, and H. C. Krieg, Jr. (assigned to TRW, Inc.). Alumina Extraction From Alumino-Silicate Ores and Potassium Sulfate Ores. U.S. Pat. 3,652,208, Mar. 28, 1972.

either SO_2 or CO_2. The aluminum trihydrate is calcined to yield alumina. Some of the potassium carbonate or sulfite is recylced back into the processing stream, and the balance is converted to marketable potassium salts such as potassium sulfate or potash.

The efficient conversion of aluminum nitrate solution to cell-grade alumina was outlined in another patent.[29] This difficult conversion of aluminum nitrate solution was a longstanding problem associated with the nitric acid processes for "opening-up" clays. The conversion was accomplished by introducing the solution into a fluidized bed under conditions that allow recovery of the bulk of the nitrate values as nitric acid vapor while forming a residual hydrous aluminum nitrate solid. The solid is heated further to remove residual water and nitrate values and to convert the alumina to α- alumina.

A process for the direct production of aluminum-silicon alloys, containing more than 50% by weight of aluminum, from alumina-bearing ores was patented.[30] The alloys are produced by reducing stoichiometric amounts of aluminum and silicon along with predetermined amounts of water of hydration. Thermal reduction is successfully carried out with a materials throughput rate adequate to effect hydration but insufficient for densification and induration. Densification and induration of the material, prior to introduction to the furnace reaction zone, could be detrimental to the alloying reactions. A patent for producing aluminosilicate alloys by directly industry participation in building and opalso granted.[31] Sized ores, such as kaolin clays, bauxite, and kyanite, are fluidized in a stream of chlorine gas between 950° and 1,200°C sufficiently to volatilize the iron and titanium contaminants, thereby leaving the residual aluminum-silicon alloy.

Alumina from nonbauxite ores was the topic of a comprehensive report issued by a panel of the National Academy of Sciences.[32] The most promising domestic sources of alumina (other than commercial bauxite) were reviewed, basic approaches to the processing of clays and other sources were examined, and the most workable processes were appraised. Hydrochloric and nitric acid processes for treating clays appeared to be the most promising for economic production of alumina from nonbauxitic ores. Experimental and pilot plant data on other processes and/or ores were judged to be noncompetitive with the acid processes. The panel also recommended joint Government and aluminum chloridizing aluminosilicate materials was erating two 5-ton-per-day alumina plants. One plant was to use the "promising" hydrochloric acid technique, and the other the "best" proposed nitric acid method. The Georgia Department of Trade and Industry (GDTI), responding to the panel's recommendation, proposed a joint venture with the Federal Government using local supplies of kaolin as feedstock.[33]

The Georgia Institute of Technology, in a separate report prepared for the GDTI, recommended using the Hyde-Margonlin nitric process for the joint venture.[34] The alumina can be produced by this process from kaolin for $54 per ton commercially or only $4 above prices for bauxite alumina.

A detailed article on the kaolin industry in the United Kingdom was published.[35] The article covered mining and processing techniques, technological advances, environmental issues, markets, products, individual companies, and the future of the kaolin industry in Great Britain. The smaller scale European and Japanese kaolin industries were surveyed thoroughly in another report.[36] Selected mining and processing methods used by the California clay industry, in Amador, Calaveras, Kern, and Mono Counties, along with a discussion on the recovery of alum and alumina from other California ores, were highlighted in a State publication.[37]

---

[29] Huska, P. A., H. P. Meissner, and T. J. Lamb. Method and Apparatus for Converting Aluminum Nitrate Solution to Alpha Alumina. U.S. Pat. 3,647,373, Mar. 7, 1972.

[30] Schmidt, W., and H. Martin. Process for the Thermal Reduction of Alumina-Bearing Ores. U.S. Pat. 3,655,362, Apr. 11, 1972.

[31] Hildreth, C. L. Chloridizing Alumina-Containing Ore. U.S. Pat. 3,704,113, Nov. 28, 1972.

[32] National Materials Advisory Board, National Academy of Sciences—National Academy of Engineering. Processes for Extracting Alumina From Nonbauxitic Ores. Report of the Panel on Potentials of Aluminum Extractive Processes of the Committee on the Technical Aspects of Critical and Strategic Materials. Pub. NMAB-278, December 1970, 88 pp.

[33] Page 38 of work cited in footnote 6.

[34] Ward, W. C., Jr., J. E. Husted, W. C. Howard, and A. Collins. Alumina From Kaolin Potentials. Georgia Institute of Technology, April 1972, 64 pp.

[35] Industrial Minerals. No. 52, January 1972, pp. 9–29.

[36] Pages 9–19 of work cited in footnote 11.

[37] California Geology. V. 25, No. 10, October 1972, pp. 222–238.

The geologic relations, exploration and development trends, and consumption patterns for kaolins of the Southeastern United States were presented at the annual AIME meeting.[38] A similar oral presentation on the ball clays of Tennessee and Kentucky was also given at the annual AIME meeting.[39] A comprehensive thesis on the occurrences, properties, and uses of fuller's earth, bentonite, attapulgite, other absorptive clays, and the kaolin industry of the South was published.[40] An article discussing ore controls in the Eufaula bauxite-kaolin district in southeastern Alabama, an important source of domestic fire clays, its expanding mining operations, and the difficulties in finding ore reserves was published.[41] The investigation of the Eufaula district ores included detailed geological mapping of mines, in part based on auger and core drilling in selected areas combined with mineralogical analyses.

The reaction products in clay-lime-water systems, including those containing kaolin, under conditions appropriate to soil stabilization, have been extensively studied and reviewed.[42] The reaction products fall into two main categories, hydrous calcium silicates and aluminates. These silicates and aluminates are the principal components of portland cements and have hydraulic properties. The effect of typical kaolin impurities, such as MgO, FeO, ZnO, and CuO, on forming solid solutions during firing in the solid-state temperature ranges was studied.[43] This work, although theoretical and unreported in nature, should be applicable to the manufacturing of structural clay products.

A patent for producing high-brightness coating clays by a novel magnetic separation-glass bead grinding technique was awarded to the J. M. Huber Corp.[44] Another patent describing a method to remove colored titania impurities from kaolin by selective flocculation was also issued.[45] Results of laboratory and road tests showed that calcined, waterwashed, and delaminated kaolin used as an extender was either equal to or superior to talc and extended TiO_2 in three vehicle systems used in traffic paints.[46] These laboratory tests also demonstrated that calcined kaolin provided more abrasion resistance in traffic paints and was superior to all other extenders. Data on the effect of kaolin and other mineral fillers on the mechanical properties of polyester castings were added to the technical literature.[47] Fillers were used in polyesters, principally by the furniture and cultured marble industries, to achieve specific properties while reducing the volumetric cost of the casting.

A derivatographic[48] method has been developed to both identify and estimate clay minerals associated with Indian coals and permit correlating the clay content with clinkering and ashing behavior during combustion.[49] The major clay minerals and their combustion behavior were determined by combined derivatographic and X-ray diffractometric studies of both ashed and unashed coals. Detailed geological and laboratory studies of the Indian china clay deposits at Singhbhum (Bihar) and the Mayurbhanj district (Orissa) were included in Indian publications. The report on Singhbhum clays also correlated chemical analysis and physical properties with application by the domestic ceramic, textile, paper, rubber, paint, and other industries.[50] The mineralogical characteris-

---

[38] Smith, J. M., and H. H. Murray. Kaolins of the Southeastern U.S. Pres. at Fall Meeting, Soc. Min. Eng., AIME, Birmingham, Ala., Oct. 18–20, 1972, SME Preprint 72–H–340, 11 pp.

[39] Phelps, G. W. The Ball Clays of Tennessee and Kentucky. Pres. at Fall Meeting, Soc. Min. Eng., AIME, Birmingham, Ala., Oct. 18–20, 1972, SME Preprint 72–H–305, 11 pp.

[40] Puri, H. S. (ed.). Geology of Phosphate, Dolomite, Limestone, and Clay Deposits. Proc. 7th Forum on Geol. Ind. Miner., Tampa, Fla., Apr. 28–30, 1971. Florida Dept. Nat. Res., Spec. Pub. 17, June 1972, pp. 37–179.

[41] Clarke, O. M., Jr. Ore Controls in Eufaula Bauxite-Kaolin Dist. Trans., AIME, v. 252, p. 167–169.

[42] Vail, J. W., and J. D. de Wet. Hydrogarnet Phase in Kaolinite-Lime-Water Slurries. J. Am. Ceram. Soc., v. 55, No. 8, August 1972, p. 432.

[43] Segnit, E. R., and T. Gelb. Metastable Quartz-Type Structures Formed From Kaolinite by Solid-State Reaction. Am. Miner., v. 57, Nos. 9–10, September–October 1972, pp. 1505–1514.

[44] Whitley, J. B., and J. Iannicelli (assigned to J. M. Huber Corp.). Method for Producing Mineral Products. U.S. Pat. 3,667,689, June 6, 1972.

[45] Mercade, V. V. Purification of Clay by Selective Flocculation. U.S. Pat. 3,701,417, Oct. 31, 1972.

[46] Brooks, L. E., and W. R. Tooke, Jr. Effect of Extenders on Traffic Paint Performance. Am. Paint J., v. 57, No. 28, Dec. 25, 1972, pp. 32–52.

[47] Jones, W. C., III, and A. L. Fricke. Fillers vs. Properties of a Ductile Polyester. Modern Plastics, v. 49, No. 4, April 1972, pp. 88–93.

[48] Derivatography gives three different functions simultaneously: (1) Differential thermal analysis, (2) thermogravimetry, and (3) derivative thermogravimetric analysis.

[49] Mukherjee, S. N., A. K. Nag, and S. K. Majumdar. A Study on the Clay Minerals in Coals by Derivatography. J. Mines, Metals, and Fuels, v. 20, No. 12, December 1972, pp. 363–373.

[50] Schrivastava, R. C. B. China Clay Deposits of Singhbhum (Bihar). Indian Min. Eng. J., v. 11, No. 9, September 1972, pp. 18–23.

tics of the Mayurbhanj clays were stressed in a second publication.[51]

An article discussed the more important worldwide producers of clay and nonclay refractory raw materials.[52] The clay refractories discussed were the medium- and high-alumina materials of the aluminosilicate range. The nonclay materials discussion was restricted to the basic refractories; namely, magnesia types and olivine. A general introduction to the field of refractories—raw materials used, manufacturing methods, tests and specifications, end uses of the refractory products, and the general industry structure—was highlighted in another publication.[53] A detailed discussion of the U.S. refractory industry was detailed in another work.[54] A similar in-depth study of the refractory industry of the United Kingdom was also published.[55]

Thorough articles on two major domestic refractory aggregate producers, Mulcoa in Georgia and the Interpace Corp. in California, were published. The chemistry, mining, processing, and marketing of Mulcoa's entire range of refractory grogs, containing 45% to 70% Al_2O_3, were treated in one publication.[56] The other article afforded a similar exhaustive treatment of the California operation.[57] A flow diagram for producing Interpace's very pure calcined kaolin was also given. Physical and chemical properties of blast furnace stove refractories, with particular emphasis on checkers, were reviewed.[58] Zoned refractory checker settings were suggested for dome temperatures from 2,100° to 2,600°F.

A dossier on fuller's earth was published by the United Kingdom Department of Trade and Industry, collating the factural data presently available.[59] Comprehensive articles on the structure and properties of montmorillonites and attapulgite and their activated products, along with the industrial markets for attapulgite and the calcium and sodium bentonites, were published.[60] A compendium on Engelhard Minerals & Chemicals Corp's attapulgite operation, with particular emphasis on end uses, mining, and processsing, was also added to the literature.[61] A similar detailed article on International Minerals and Chemical Corp.'s southern bentonite facility was also published.[62] The use of industrial minerals, such as bentonite and attapulgite, in preparing water-and oil-base drilling fluids, along with the drilling and techniques used, was surveyed in another publication.[63]

A concise work on producing high-quality rotary kiln lightweight aggregates for block, structural, and highway surface application was published.[64] The article also compared physical test results obtained from typical lightweight aggregates with selected rigid building and highway specifications. The raw materials, clay and shale, slates, and others, used in making structural lightweight and ultra-lightweight aggregates were discussed extensively in a Government publication.[65]

---

[51] Kara, V. K., S. Bose, and B. R. Sant. Some Mineralogical Characteristics of The Clays of Mayurbhanj District, Orissa. J. Mines, Metals, and Fuels, v. 20, No. 6, June 1972, pp. 188–190.

[52] Pages 9–30 of work cited in footnote 13.

[53] Pages 9–23 of work cited in footnote 15.

[54] Pages 9–27 of work cited in footnote 2.

[55] Pages 9–43 of work cited in footnote 6.

[56] Industrial Minerals. No. 56, May 1972, pp. 17–22.

[57] Pages 37–41 of work cited in footnote 13.

[58] Russel, G. A., Jr. Selection of Refractories for Modern Blast Furnace Stoves. Iron and Steel Eng., v. 49, No. 2, February 1972, pp. 42–48.

[59] Highley, D. E. Fuller's Earth. Mineral Resources Consultative Committee, Mineral Dossier 3 (H.M.Sta. Off.), 1972, 26 pp.

[60] Industrial Minerals. No. 63, December 1972, pp. 9–47.

[61] Haden, W. L., Jr. Attapulgite. Pres. at Fall Meeting, Soc. Min. Eng., AIME, Birmingham, Ala., Oct. 18–20, 1972, SME Preprint 72–H–327, 8 pp.

[62] Teague, K. H. Southern Bentonite. Pres. at Fall Meeting, Soc. Min. Eng., AIME, Birmingham, Ala., Oct. 18–20, 1972, SME Preprint 72–H–328, 7 pp.

[63] Industrial Minerals. No. 60, September 1972, pp. 9–31.

[64] Cohen, S. M., and N. W. Biege. Lightweight Aggregate Designing and Operating for Quality Product. Pit and Quarry, v. 65, No. 2, August 1972, pp. 107–111.

[65] Bush, A. L. Lightweight Aggregates. Ch. in United States Mineral Resources, ed. by D. A. Brobst and W. P. Pratt. U.S. Geol. Survey Prof. Paper 820, 1973, pp. 333–355.

Coal—Bituminous and Lignite

By L. W. Westerstrom [1]

CONTENTS

Bituminous coal and lignite production increased from 552.2 million tons in 1971 to 595.4 million tons in 1972. The increase occurred primarily as a result of the increased demand for coal by electric utilities and a rebuilding of inventories which had been heavily drawn down during the negotiation of a new wage agreement late in 1971. Production from deep mines increased in all major coal producing States, while production from surface mine increased in Western States and in Alabama, Illinois, and Indiana, but declined in Ohio, Pennsylvania, and West Virginia.

The average f.o.b. mine value of coal increased from $7.07 per ton in 1971 to $7.66 per ton in 1972. The average price of coal at underground and strip mines increased from $8.87 to $9.70 per ton and from $5.19 to $5.48 per ton respectively. The average rail freight charge on coal declined from $3.70 per ton in 1971 to $3.67 per ton in 1972. The decline occurred because there were no general freight rate increases until late in the year, and unit-train traffic, which has lower per-ton-mile costs, increased nearly 14 million tons.

Consumption of bituminous coal and lignite in the United States increased 5.0% principally at electric utility and oven-coke plants. The remaining principal types of consumers used less coal than in the previous year. Consumer stock piles were replenished throughout the year and at the end of December inventories had been increased by over 21 million tons.

Employment increased from 145.7 thousand men in 1971 to 149.3 thousand in 1972. Employment in 1972 continued the upward trend since 1969 as productivity, measured by tons of output per man per day, declined for the third consecutive year. However, the amount of decline was considerably less than 1970 and 1971.

The average output per man per day at all mines fell from 18.02 tons per man per day in 1971 to 17.74 tons in 1972. At underground mines output declined from 12.03 tons to 11.91 tons while output at strip mines increased from 35.69 tons to 35.95 tons per man per day.

[1] Industry economist, Division of Fossil Fuels—Mineral Supply.

This chapter includes data on all bituminous coal and lignite output in the United States by operations that produced 1,000 tons or more per year. All quantity figures represent net tons of marketable coal and exclude washery and other refuse. Statistics are final and are based upon detailed annual reports of production and mine operations furnished by producers. For production not directly reported, chiefly that of small mines, data was obtained from the records of the various State mine departments, which have statutory authority to require such reports.

The monthly and weekly estimates of production, summarized in tables 4 and 9, are based upon railroad carloadings of coal reported weekly by railroads, and shipments on the Allegheny and Monongahela Rivers, reported by the U.S. Army Corps of Engineers, direct reports from mining companies, and monthly production statements compiled by certain local operators' associations and State mine departments.

DISTRIBUTION AND SHIPMENTS

Shipments of bituminous coal and lignite, summarized in tables 33 to 36, show by district of origin, State of destination, type of consumer use, and by method of transportation, the participation of coal in various local and national markets.

The distribution data by consumer use do not necessarily conform to the consumption data because the latter represents actual use at consumer facilities, whereas the distribution data represents shipments from the mines, some of which were in transit or in consumers' storage.

Total shipments increased from 553.1 million tons in 1971 to 595.2 million tons in 1972. There were large increases in shipments to electric utility and oven-coke plants. However, receipts of coal by consumers in all other industrial fuel markets and to retail dealers were down 3.6 and 1.6 million tons respectively. Miscellaneous items such as railroad fuel, mine fuel, Canadian and U.S. Great Lakes dock storage accounts, and net changes in mine inventory increased 0.9 million tons.

The distribution data are based on receipts submitted quarterly to the Bureau of Mines voluntarily by producers, sales agents, distributors, and wholesalers, who normally produce or sell 100,000 tons or more annually. The cooperation of these respondents resulted in their reporting about 93% of all coal produced or shipped. To account for total industry shipments, estimates for the remaining shipments are included, based on data from coal trade and other reliable coal statistical reporting agencies.

Additional details of bituminous coal and lignite distribution for 1972 are presented in a Bureau of Mines report.[2]

[2] Bureau of Mines. Bituminous Coal and Lignite Distribution, Calendar Year 1972. Mineral Industry Survey, April 9, 1973, 39 pp.

FOREIGN TRADE

In 1972 the United States exported 56.0 million tons of coal, a decrease of 0.7 million tons from that of 1971. Japan maintained its position as the principal U.S. foreign market with a 32.1% share of total U.S. coal exports. Shipments of coal to Canada, Europe, and South America accounted for 33.3%, 29.8%, and 4.8%, respectively. The slight decline in coal exports in 1972 was the result of a generally lower steel demand abroad, adequate coal stocks, and an improved world coking coal supply. The lower steel demand in Europe led to a buildup of stockpiles principally in Western Europe.

WORLD REVIEW

World production of bituminous coal and lignite in 1972 was estimated at 3,160 million tons an increase of 1.2 percent over that of the previous year. In Europe, production decreased from 1,814 million tons to 1,786 million tons. Production of bituminous coal and lignite in the U.S.S.R., the largest coal producing country in the world, was estimated at 637 million tons in 1972, an increase of 14 million tons over 1971 figures. Coal production in Asia increased 1.3% from the revised 1971 tonnage. The Peoples' Republic of China, the third largest coal-producing country in the world, increased its production from 430 million tons in 1971 to 440 million tons in 1972.

TECHNOLOGY

Major emphasis in coal research in 1972 was placed on the production of clean burning fuels from coal to help meet the Nation's rapidly increasing need for energy, while at the same time maintaining or improving the quality of the environment.

On the basis of a 2-year detailed study, the National Academy of Engineering's (NAE) Committee on Air Quality Management Ad Hoc Panel on Evaluation of Coal Gasification Technology concluded that pilot plant work on the Bureau of Mines' SYNTHANE Process should be expedited as one of the four most important American processes for converting coal to substitute natural gas (SNG). In addition NAE's Ad Hoc Panel found that the Bureau's HYDRANE hydrogasification process for SNG showed great promise and recommended further development.

The soundness of the basic design of the Bureau of Mines SYNTHANE Process was established in test operation of a 740 pounds-per-hour coal gasification pilot plant. The gasifier was operated under contract with an outside engineering firm to provide information on critical elements of the SYNTHANE Process design and to assist with the startup of the 75 ton-per-day pilot plant, for which ground breaking ceremonies were held at the Bureau's Bruceton, Pa. facilities in February 1973.

During the year bituminous coal was successfully processed in the Bureau's 10-pound-per-hour HYDRANE unit. In these tests it was confirmed that strongly caking coal could be processed without first treating the coal to destroy its caking characteristics. Because up to 95% of the methane produced results from the direct reaction of hydrogen with coal, this process offers further economic advantage over other coal gasification schemes in that a minimum amount of methanation is required to convert the gases from the gasifier to pipeline quality gas.

In other coal gasification research, strongly caking coal from the Upper Freeport seam in Preston County, W. Va., was gasified in a stirred-bed pressurized producer at 125 pounds per square inch gauge (psig), and a side stream of the gas was processed to remove up to 98% of the H_2S. This latter step was accomplished by means of a solid absorbent consisting of 25% iron oxide and 75% fly ash.

During the year, the Bureau initiated a pilot field experiment to establish the feasibility of gasifying Western subbituminous coals in place. The site for the test is near Hanna, Wyo. The coalbed is 30 feet thick and lies under 400 feet of overburden. Preliminary tests showed the need to increase the permeability of the coalbed to permit unrestricted flow of gasification gases. This was accomplished by hydrofracturing the coalbed between a specially-designed pattern of vertical boreholes. Gasification of the coal was then started by using air as the gas-making fluid. Later oxygen or oxygen-enriched air can be substituted to obtain a high-quality product gas. Underground coal gasification could provide a major source of clean energy that would significantly reduce or eliminate many of the problems associated with conventional underground mining.

Experiments were successfully concluded in a small laboratory process-development unit after showing that coal containing nearly 5% sulfur and 16% ash could be liquefied with hydrogen to yield a premium fuel oil essentially ash free and containing only 0.2% sulfur. A larger diameter reacter was constructed to study flow problems that may be encountered in scale-up of the process.

During the year construction was undertaken on a 3-stage high-temperature coal combustion pilot plant designed to produce a low-ash, high-temperature gas suitable for open-cycle magneto hydrodynamic (MHD) power generation. The design called for the gasifier combustor system to have a nominal capacity of 1,000 pounds of coal per hour and to operate at 8 atmospheres pressure. It is anticipated that the gas leaving the second stage will be at 2,300°F and have the composition of a good producer gas. The gas will be suitable for combined gas turbine-steam turbine electric power generation plant after removing particulate matter and sulfur.

Research on mine waste land reclamation emphasized work on bituminous spoil and anthracite refuse banks. In one project 5 acres of an anthracite refuse bank near Wilkes-Barre, Pa., were treated with 1,500 tons of anthracite fly ash, and then seeded with grass-legume mixture. On one-half of the treated area, about 300 tons per acre of fly ash was applied to the ground surface and mixed with surface refuse, while on the other half the fly ash was spread in a layer over the surface but not mixed. Lime was also added at the rate of 5 tons per acre to neutralize the fly ash and the anthracite refuse. In a second project, a coal company, an electric utility, and a volunteer group of concerned citizens joined to convert a coal mine refuse pile into a recreation park at Century in Barbour County, W. Va., Transformation of the waste land was accomplished through a procedure developed by Bureau researchers utilizing fly ash as a soil amendment. In a related project, two test plots on graded spoil were established in North Dakota, one at the North Beulah mine and the second at the Center mine. The first plot features a monospecies on a graded series of soils from various depths in the mining profile and tests the effectiveness of phosphate fertilizer, slack coal, and both, on vegetative viability. The second plot features mixed grass seeding on graded spoil treated with slack coal and nitrogen-phosphorus fertilizer.

Bureau personnel cooperated in a pilot plant SO_2 removal study conducted at a midwestern power and light company. The program, which lasted about 3 weeks, had as its objective determination of the amount of SO_2 that can be removed from the powerplant stack gases, using as the scrubbing medium the soluble alkali extracted with water from the ash in Montana subbituminous coal. The procedure is similar to that researched on a smaller scale at the Bureau's laboratory.

Table 1.—Salient statistics of the bituminous coal and lignite industry in the United States

Item	1968	1969	1970	1971	1972
Production thousand short tons	545,245	560,505	602,932	552,192	595,386
Value thousands	$2,546,340	$2,795,509	$3,772,662	$3,904,562	$4,561,983
Consumption thousand short tons	498,830	507,275	515,619	494,862	516,776
Stocks at end of year:					
Industrial consumers and retail yards thousand short tons	85,525	80,482	92,275	89,985	114,351
Stocks on upper lake docks do	1,937	1,484	1,468	1,205	939
Exports [1] do	50,637	56,234	70,944	56,633	55,960
Imports [1] do	224	109	36	111	47
Price indicators, average per net ton:					
Cost of coking coal at merchant coke ovens	$10.58	$10.75	$12.28	$15.32	$16.25
Railroad freight charge [2]	$3.01	$3.10	$3.41	$3.70	$3.67
Value f.o.b. mines (sold in open market)	$4.38	$4.65	$5.89	$6.66	$7.35
Value f.o.b. mines	$4.67	$4.99	$6.26	$7.07	$7.66
Method of mining:					
Hand-loaded underground thousand short tons	14,755	11,700	9,599	4,992	2,974
Mechanically loaded underground do	329,387	335,431	329,189	270,896	301,129
Percentage mechanically loaded	95.7	96.6	97.2	98.2	99.0
Percentage cut by machine	48.4	46.2	46.1	40.6	37.4
Mined by stripping thousand short tons	185,836	197,023	244,117	258,972	275,730
Percentage mined by stripping	34.1	35.2	40.5	46.9	46.3
Mined at auger mines thousand short tons	15,267	16,350	20,027	17,332	15,554
Percentage mined at auger mines	2.8	2.9	3.3	3.1	2.6
Mechanically cleaned thousand short tons	340,923	334,761	323,452	271,401	292,829
Percentage mechanically cleaned	62.5	59.7	53.6	49.1	49.2
Number of mines	5,327	5,118	5,601	5,149	4,879
Capacity at 280 days thousand short tons	694,000	694,000	740,000	736,000	741,000
Average number of men working daily:[3]					
Underground mines	102,940	99,269	107,808	109,311	112,252
Strip mines	22,358	22,323	28,395	32,979	34,027
Auger mines	2,596	2,940	3,937	3,374	2,986
Total number of men working daily	127,894	124,532	140,140	145,664	149,265
Average number of days worked:[3]					
Underground mines	217	224	229	210	227
Strip mines	243	247	236	220	225
Auger mines	145	139	148	132	121
Average, all mines	220	226	228	210	225
Production per man per day:[3]					
Underground mines short tons	15.40	15.61	13.76	12.03	11.91
Strip mines do	34.24	35.71	35.96	35.69	35.95
Auger mines do	40.46	39.88	34.26	39.00	43.00
Average, all mines do	19.37	19.90	18.84	18.02	17.74

[1] Bureau of the Census, U.S. Department of Commerce.
[2] Interstate Commerce Commission.
[3] Estimates based on data supplied by Health and Safety Analysis Center, Mining Enforcement and Safety Administration.

Table 2.—Coal reserves of the United States, January 1, 1972, by State

(Million short tons)

State	Date of publication of estimate	Estimated original reserves: Bituminous coal	Estimated original reserves: Subbituminous coal	Estimated original reserves: Lignite	Estimated original reserves: Anthracite and semi-anthracite	Total	Reserves depleted to Jan. 1, 1972: Production [1]	Reserves depleted to Jan. 1, 1972: Production plus loss in mining [2]	Remaining reserves, Jan. 1, 1972	Recoverable reserves Jan. 1, 1972, assuming 50% recovery
Alabama	1958	[3] 13,754	--	20	--	13,774	[4] 206	412	13,362	6,681
Alaska	1967	19,429	[5] 110,696	(5)	--	130,125	22	44	130,081	65,040
Arkansas	1960	1,816	--	350	456	2,622	103	206	2,416	1,208
Colorado	1959	63,203	18,492	--	90	81,785	563	1,126	80,659	40,330
Georgia	1946	24	--	--	--	24	3	6	18	9
Illinois	1965	[6] 140,000	--	--	--	140,000	[4] 438	876	139,124	69,562
Indiana	1953	37,293	--	--	--	37,293	1,358	2,716	34,577	17,288
Iowa	1965	7,237	--	--	--	7,237	364	728	6,509	3,254
Kansas	1957	[7] 18,706	--	(8)	--	18,706	[4] 17	34	18,672	9,336
Kentucky	1963	72,318	--	--	--	72,318	3,739	7,478	64,840	32,420
Maryland	1967	[9] 1,200	--	--	--	1,200	[4] 21	42	1,158	579
Michigan	1950	297	--	--	--	297	46	92	205	102
Missouri	1967	23,977	--	--	--	23,977	327	654	23,323	11,662
Montana	1949	2,363	132,151	87,533	--	222,047	185	370	221,677	110,838
New Mexico	1950	10,948	50,801	--	6	61,755	165	330	61,425	30,712
North Carolina	1949	112	--	--	--	112	1	2	110	55
North Dakota	1953	--	--	350,910	--	350,910	140	280	350,630	175,315
Ohio	1960	46,488	--	--	--	46,488	2,564	5,128	41,360	20,680
Oklahoma	1957	3,673	--	(8)	--	3,673	196	392	3,281	1,640
Oregon	1965	50	--	--	--	50	4	8	42	21
Pennsylvania [10]	(B) 1928 (A) 1945	75,093	290	--	22,805	98,188	14,511	29,022	69,166	34,583
South Dakota	1952	--	--	2,033	--	2,033	1	2	2,031	1,016
Tennessee	1959	[11] 2,748	--	--	--	2,748	[4] 89	178	2,570	1,285
Texas [10]	(B) 1967 (L) 1955	6,100	--	7,070	--	13,170	128	256	12,914	6,457

See footnotes at end of table.

Table 2.—Coal reserves of the United States, January 1, 1972, by State—Continued

(Million short tons)

State	Date of publication of estimate	Estimated original reserves: Bituminous coal	Estimated original reserves: Subbituminous coal	Estimated original reserves: Lignite	Estimated original reserves: Anthracite and semianthracite	Total	Reserves depleted to Jan. 1, 1972: Production [1]	Reserves depleted to Jan. 1, 1972: Production plus loss in mining [2]	Remaining reserves, Jan. 1, 1972	Recoverable reserves Jan. 1, 1972, assuming 50% recovery
Utah	1967	32,678	156	--	--	32,834	314	628	32,206	16,103
Virginia	1952	11,696	--	--	355	12,051	1,177	2,354	9,697	4,848
Washington	1960	1,869	4,194	117	5	6,185	1	2	6,183	3,092
West Virginia	1940	116,618	--	--	--	116,618	7,995	15,990	100,628	50,314
Wyoming	1950	13,235	[12] 108,319	([12])	--	121,554	449	898	120,656	60,328
Other States	1967	[13] 620	[14] 4,065	[15] 50	--	4,735	8	16	4,719	2,360
Total [16]	--	723,545	429,164	448,083	23,717	1,624,509	[17] 35,135	70,270	1,554,239	777,119

[1] Production, 1800 through 1885, from "The first century and a quarter of American coal industry," by H. N. Eavenson, privately printed, Pittsburgh, 1942; production, 1886 through 1923, from U.S. Geological Survey Mineral Resources, annual volumes; production, 1924 through 1971, from Bureau of Mines, Minerals Yearbook, annual volumes, augmented for some States by records of State mine inspectors.
[2] Assuming past losses equal past production.
[3] Remaining reserves Jan. 1, 1958.
[4] Production from year that remaining reserves were estimated through 1971.
[5] Small resources and production of lignite included under subbituminous coal.
[6] Remaining reserves Jan. 1, 1965.
[7] Remaining reserves Jan. 1, 1957.
[8] Small reserves of lignite in beds generally less than 30 inches thick.
[9] Remaining reserves Jan. 1, 1950.
[10] A–Anthracite; B–Bituminous; L–Lignite.
[11] Remaining reserves Jan. 1, 1959.
[12] Small reserves and production of lignite included under subbituminous coal.
[13] Arizona, California, Idaho, Nebraska, and Nevada.
[14] Arizona, California, and Idaho.
[15] California, Idaho, Louisiana, Mississippi, and Nevada.
[16] Data may not add to totals shown because of independent rounding.
[17] Less than total recorded cumulative production of about 38 billion tons. See footnotes 3, 4, 6, 7, 9, and 11.

Source: Averitt, Paul. Coal Resources of the United States, Jan. 1, 1967. Geological Survey Bulletin 1275, pp. 10–11.

Table 3.—Annual average unit heat value of bituminous coal and lignite produced and consumed in the United States, 1955–1972 [1]

(British thermal units (Btu) per pound)

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	12,920
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	r 13,385	r 12,120	494,862	r 11,857	r 11,980
1972	595,386	14,319	12,025	516,776	12,273	11,875

r Revised.

[1] Prior to 1972 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 65% 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.

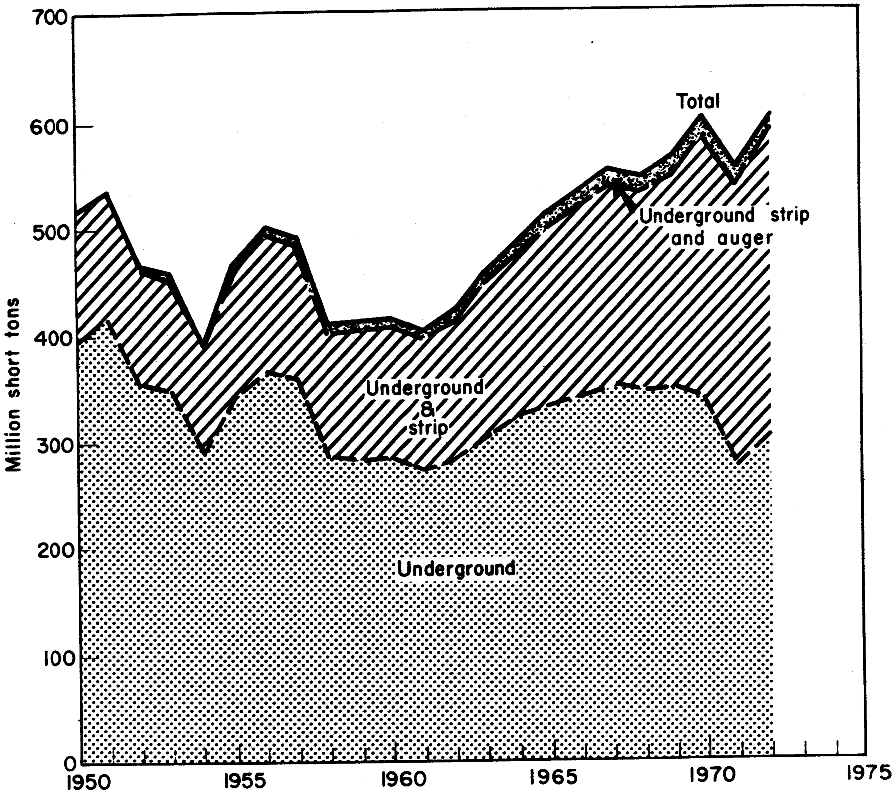

Figure 1.—Production of bituminous coal and lignite, by type of mining in the United States.

Table 4.—Production of bituminous coal and lignite in the United States, with estimates by week

(Thousand short tons)

Week ended	Production 1971	Maximum number of working days	Average production per working day	Week ended	Production 1972	Maximum number of working days	Average production per working day
Jan. 2	[1] 478	[1] 0.3	[2] 478	Jan. 8	11,696	6	1,949
Jan. 9	11,697	6	1,950	Jan. 15	12,125	6	2,021
Jan. 16	12,717	6	2,120	Jan. 22	11,691	6	1,949
Jan. 23	12,588	6	2,098	Jan. 29	12,015	6	2,003
Jan. 30	12,300	6	2,050	Feb. 5	11,645	6	1,941
Feb. 6	10,996	6	1,828	Feb. 12	11,712	6	1,952
Feb. 13	11,398	6	1,900	Feb. 19	12,069	6	2,012
Feb. 20	12,119	6	2,020	Feb. 26	11,502	6	1,917
Feb. 27	12,516	6	2,086	Mar. 4	10,999	6	1,833
Mar. 6	11,742	6	1,957	Mar. 11	11,462	6	1,910
Mar. 13	12,693	6	2,116	Mar. 18	11,838	6	1,973
Mar. 20	12,467	6	2,078	Mar. 25	12,466	6	2,078
Mar. 27	13,188	6	2,198	Apr. 1	12,010	5.3	2,266
Apr. 3	11,743	5.3	2,216	Apr. 8	12,483	6	2,081
Apr. 10	12,504	6	2,084	Apr. 15	12,190	6	2,032
Apr. 17	12,741	6	2,124	Apr. 22	12,469	6	2,078
Apr. 24	12,504	6	2,084	Apr. 29	12,672	6	2,112
May 1	12,355	6	2,059	May 6	11,372	6	1,895
May 8	12,642	6	2,107	May 13	11,502	6	1,917
May 15	12,360	6	2,060	May 20	11,990	6	1,998
May 22	10,990	6	1,832	May 27	12,125	6	2,021
May 29	13,769	6	2,295	June 3	10,765	5	2,153
June 5	11,215	5.1	2,199	June 10	13,206	6	2,201
June 12	12,649	6	2,108	June 17	13,191	6	2,199
June 19	9,346	6	1,558	June 24	12,521	6	2,087
June 26	12,289	6	2,048	July 1	6,624	3.1	2,137
July 3	6,922	3.9	1,775	July 8	4,438	2.1	2,113
July 10	4,746	2.3	2,063	July 15	10,475	4.8	2,182
July 17	10,789	6	1,798	July 22	11,605	6	1,934
July 24	11,077	6	1,846	July 29	11,889	6	1,982
July 31	9,802	6	1,634	Aug. 5	11,340	6	1,890
Aug. 7	11,560	6	1,927	Aug. 12	11,900	6	1,983
Aug. 14	13,214	6	2,202	Aug. 19	11,419	6	1,903
Aug. 21	13,184	6	2,197	Aug. 26	11,002	6	1,834
Aug. 28	13,229	6	2,205	Sept. 2	11,604	6	1,934
Sept. 4	13,506	6	2,251	Sept. 9	10,289	5	2,058
Sept. 11	11,450	5	2,290	Sept. 16	11,966	6	1,994
Sept. 18	12,807	6	2,135	Sept. 23	12,280	6	2,047
Sept. 25	12,770	6	2,128	Sept. 30	11,966	6	1,994
Oct. 2	11,244	6	1,874	Oct. 7	11,569	6	1,928
Oct. 9	2,715	1.5	1,810	Oct. 14	12,120	6	2,020
Oct. 16	2,565	1.4	1,832	Oct. 21	11,702	5	2,340
Oct. 23	2,121	1.2	1,768	Oct. 28	11,773	6	1,962
Oct. 30	2,126	1.2	1,772	Nov. 4	11,899	6	1,983
Nov. 6	2,660	1.5	1,773	Nov. 11	11,914	6	1,986
Nov. 13	2,927	1.7	1,722	Nov. 18	12,042	6	2,007
Nov. 20	7,028	4	1,757	Nov. 25	10,177	5	2,035
Nov. 27	9,047	5.1	1,774	Dec. 2	11,637	6	1,940
Dec. 4	12,620	6	2,103	Dec. 9	11,620	6	1,937
Dec. 11	12,881	6	2,147	Dec. 16	10,850	6	1,808
Dec. 18	12,834	6	2,139	Dec. 23	10,541	6	1,757
Dec. 25	10,978	5	2,196	Dec. 30	9,028	5	1,806
Jan. 1	11,384	5	2,277				
Total or average [3]	552,192	271.5	2,034		595,386	298.3	1,996

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

Table 5.—Production of bituminous coal and lignite in the United States, in 1972, by State, and type of mining

(Thousand short tons)

State	Underground	Strip	Auger	Total [1]
Alabama	7,588	13,177	49	20,814
Alaska	--	668	--	668
Arizona	--	2,954	--	2,954
Arkansas	8	420	--	428
Colorado	3,070	2,452	--	5,522
Illinois	31,721	33,802	--	65,523
Indiana	1,446	24,503	--	25,949
Iowa	352	499	--	851
Kansas	--	1,227	--	1,227
Kentucky:				
Eastern	37,946	22,132	8,779	68,858
Western	18,547	33,645	137	52,330
Total [1]	56,494	55,776	8,917	121,187
Maryland	141	1,435	65	1,640
Missouri	--	4,551	--	4,551
Montana:				
Bituminous	17	7,882	--	7,899
Lignite	--	322	--	322
Total	17	8,204	--	8,221
New Mexico	1,014	7,235	--	8,248
North Dakota (lignite)	--	6,632	--	6,632
Ohio	16,269	34,077	621	50,967
Oklahoma	88	2,536	--	2,624
Pennsylvania	49,133	26,264	542	75,939
Tennessee	5,866	5,113	281	11,260
Texas (lignite)	--	4,045	--	4,045
Utah	4,770	32	--	4,802
Virginia	23,993	7,935	2,100	34,028
Washington	29	2,606	--	2,634
West Virginia	101,662	19,101	2,979	123,743
Wyoming	442	10,487	--	10,928
Total [1]	304,103	275,730	15,554	595,386

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

Table 6.—Production of bituminous coal and lignite in the United States, 1972, by district, and type of mining

(Thousand short tons)

District	Underground	Strip	Auger	Total [1]
1. Eastern Pennsylvania	21,916	21,788	441	44,145
2. Western Pennsylvania	28,778	6,778	165	35,721
3. Northern West Virginia	28,443	8,025	264	36,732
4. Ohio	16,269	34,077	621	50,967
5. Michigan	--	--	--	--
6. Panhandle	9,275	209	10	9,495
7. Southern Numbered 1	29,976	3,709	449	34,134
8. Southern Numbered 2	99,389	40,844	13,417	153,650
9. West Kentucky	18,547	33,645	137	52,330
10. Illinois	31,721	33,802	--	65,523
11. Indiana	1,446	24,503	--	25,949
12. Iowa	352	499	--	851
13. Southeastern	8,552	13,804	49	22,405
14. Arkansas-Oklahoma	96	833	--	929
15. Southwestern	--	11,946	--	11,946
16. Northern Colorado	575	--	--	575
17. Southern Colorado	3,509	2,469	--	5,977
18. New Mexico	--	10,172	--	10,172
19. Wyoming	442	10,487	--	10,928
20. Utah	4,770	32	--	4,802
21. North-South Dakota	--	6,632	--	6,632
22. Montana	17	8,204	--	8,221
23. Washington	29	3,274	--	3,302
Total [1]	304,103	275,730	15,554	595,386

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

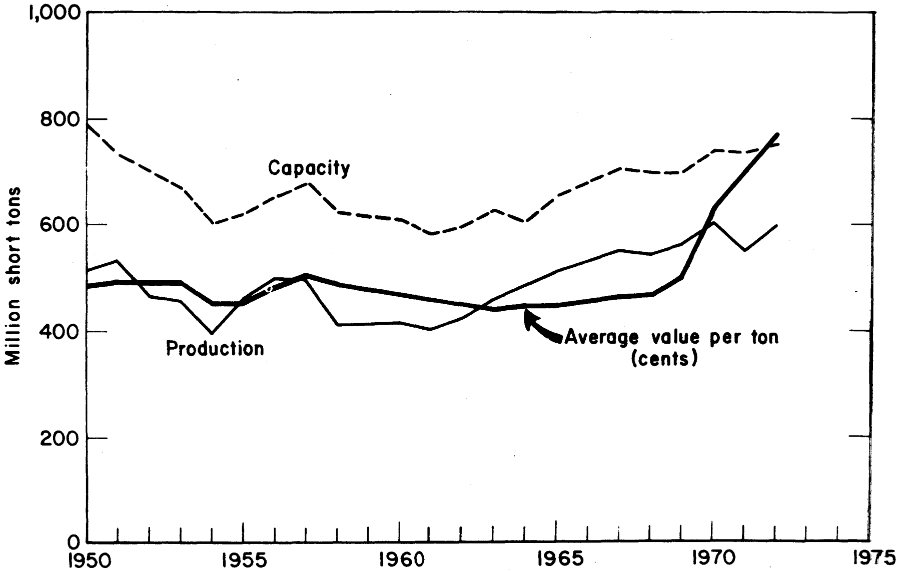

Figure 2.—Trends of bituminous coal and lignite production, realization, and mine capacity in the United States.

Table 7.—Number of mines, production, value, men working daily, days active, man-days, and output per man per day at bituminous coal and lignite mines in the United States, in 1972, by State

State	Number of active mines	Production (thousand short tons)					Average value per ton [4]	Average number of men working daily	Average number of days worked	Number of man-days worked (thousands)	Average tons per man per day
		Shipped by rail or water [1]	Shipped by truck	Mine-mouth generating plants	All other [2]	Total [3]					
Alabama	126	16,208	3,110	1,490	6	20,814	$9.63	5,062	250	1,268	16.42
Alaska	1	556	112	--	--	668	W	83	310	26	25.96
Arizona	1	--	--	--	2,954	2,954	W	103	220	23	130.35
Arkansas	8	423	5	--	--	428	10.93	165	204	34	12.74
Colorado	35	4,221	712	587	2	5,522	6.45	1,327	247	328	16.83
Illinois	59	50,766	8,976	5,642	139	65,523	6.14	10,324	260	2,686	24.39
Indiana	40	19,790	3,781	2,374	4	25,949	5.58	2,813	273	769	33.75
Iowa	11	463	377	--	10	851	4.86	141	274	39	22.04
Kansas	4	1,140	85	--	2	1,227	6.39	245	293	72	17.07
Kentucky:											
Eastern	1,355	63,879	4,937	--	42	68,858	8.01	20,206	192	3,888	17.71
Western	103	42,645	742	8,917	26	52,330	5.23	7,410	244	1,811	28.89
Total or average [3]	1,458	106,524	5,679	8,917	68	121,187	6.81	27,616	206	5,700	21.26
Maryland	55	687	954	--	--	1,640	5.46	330	187	62	26.55
Missouri	11	1,751	207	2,593	--	4,551	5.20	589	265	156	29.14
Montana:											
Bituminous	7	7,873	26	--	--	7,899	2.01	228	248	57	139.80
Lignite	2	320	2	--	--	322	2.45	19	265	5	63.94
Total or average [3]	9	8,193	28	--	--	8,221	2.03	247	249	62	133.60
New Mexico	5	1,427	5	6,816	--	8,248	3.61	580	259	150	54.92
North Dakota (lignite)	14	3,224	203	3,157	48	6,632	2.02	284	229	65	101.88
Ohio	306	32,811	12,486	5,667	2	50,967	5.96	9,509	237	2,256	22.59
Oklahoma	15	2,527	97	--	--	2,624	7.28	554	244	135	19.43
Pennsylvania	836	50,404	17,024	8,091	420	75,939	9.14	24,211	245	5,924	12.82
Tennessee	211	6,600	4,510	122	28	11,260	7.23	2,548	216	552	20.41
Texas (lignite)	3	--	240	3,805	--	4,045	W	244	300	73	55.22
Utah	22	3,877	923	--	2	4,802	8.93	1,582	225	356	13.49
Virginia	698	32,963	1,052	--	13	34,028	10.11	12,398	217	2,696	12.62
Washington	3	--	38	2,597	--	2,634	6.61	213	250	53	49.44
West Virginia	935	113,136	4,948	5,361	299	123,743	10.31	47,223	209	9,863	12.55
Wyoming	18	6,149	80	4,660	39	10,928	3.74	874	240	210	52.01
Total or average [3]	4,879	463,839	65,633	61,878	4,036	595,386	7.66	149,265	225	33,557	17.74

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 8.—Number of mines, production, value, men working daily, days active, man-days, and output per man per day at bituminous coal and lignite mines in the United States, in 1972, by district

District	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	Number of man-days worked (thousands)	Average tons per man per day
1. Eastern Pennsylvania	651	24,827	11,043	7,878	397	44,145	$8.25	13,540	239	3,241	13.62
2. Western Pennsylvania	259	28,146	7,265	243	68	35,721	9.93	11,765	247	2,909	12.28
3. Northern West Virginia	239	34,348	1,807	497	79	36,732	8.16	11,174	200	2,238	16.41
4. Ohio	306	32,811	12,486	5,667	2	50,967	5.96	9,509	237	2,256	22.59
5. Michigan	--	--	--	--	--	--	--	--	--	--	--
6. Panhandle	15	4,579	215	4,650	50	9,495	7.49	3,054	235	717	13.24
7. Southern Numbered 1	335	32,994	1,030	1	109	34,134	14.45	15,951	219	3,498	9.76
8. Southern Numbered 2	2,542	141,611	11,659	303	78	153,650	8.86	50,998	202	10,296	14.92
9. West Kentucky	103	42,645	742	8,917	26	52,330	5.23	7,410	244	1,811	28.89
10. Illinois	59	50,766	8,976	5,642	139	65,523	6.14	10,324	260	2,686	24.39
11. Indiana	40	19,790	3,781	2,374	4	25,949	5.58	2,813	273	769	33.75
12. Iowa	11	463	377	--	10	851	4.86	141	274	39	22.04
13. Southeastern	170	17,371	3,517	1,490	27	22,405	9.43	5,496	246	1,353	16.56
14. Arkansas-Oklahoma	14	925	5	--	--	929	9.04	430	188	81	11.52
15. Southwestern	27	4,916	629	6,398	3	11,946	4.86	1,367	285	389	30.69
16. Northern Colorado	3	272	301	--	1	575	5.17	164	223	37	15.74
17. Southern Colorado	34	4,979	411	587	1	5,977	7.25	1,398	253	354	16.91
18. New Mexico	4	397	5	6,816	2,954	10,172	2.68	448	248	111	91.70
19. Wyoming	18	6,149	80	4,660	39	10,928	3.74	874	240	210	52.01
20. Utah	22	3,877	923	--	2	4,802	8.93	1,582	225	356	13.49
21. North-South Dakota	14	3,224	203	3,157	48	6,632	2.02	284	229	65	101.88
22. Montana	9	8,193	28	--	--	8,221	2.03	247	249	62	133.60
23. Washington	4	556	150	2,597	--	3,302	7.07	296	267	79	41.80
Total [3]	4,879	463,839	65,633	61,878	4,036	595,386	7.66	149,265	225	33,557	17.74

[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.

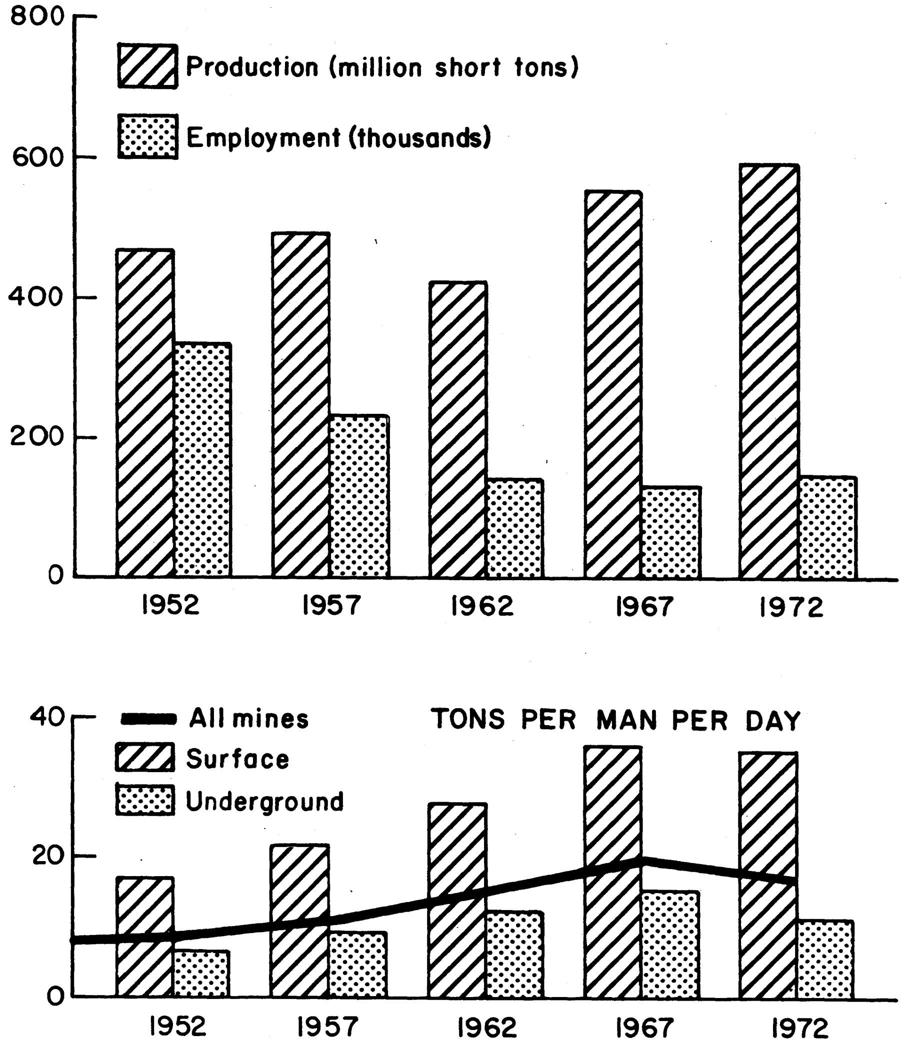

Figure 3.—Trends of employment and output per man at bituminous coal and lignite mines in the United States

Table 9.—Production of bituminous coal and lignite, in 1972, by State, with estimates by month [1]

(Thousand short tons)

State	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total [2]
Alabama	1,584	1,554	1,827	1,809	1,731	1,867	1,606	1,773	1,559	1,847	1,655	2,002	20,814
Alaska	47	50	52	57	60	58	56	61	60	58	55	54	668
Arizona	242	241	242	245	257	263	248	253	241	236	241	245	2,954
Arkansas	30	36	34	31	32	39	34	39	36	43	32	42	428
Colorado	530	511	519	395	425	395	287	494	477	488	507	494	5,522
Illinois	5,660	5,560	6,405	5,737	5,895	5,470	4,718	5,042	5,644	5,714	4,868	4,810	65,523
Indiana	1,990	2,128	2,345	2,059	2,375	2,145	2,017	2,203	2,101	2,286	2,151	2,149	25,949
Iowa	68	62	64	71	70	75	67	75	73	77	72	77	851
Kansas	124	116	105	98	110	95	92	100	97	98	93	99	1,227
Kentucky:													
Eastern	5,706	5,309	5,802	5,555	5,901	5,744	4,871	6,680	6,011	6,750	6,343	4,185	68,858
Western	4,336	4,034	4,410	4,222	4,485	4,365	3,702	5,077	4,568	5,130	4,820	3,181	52,330
Total	10,042	9,343	10,212	9,777	10,386	10,109	8,573	11,757	10,579	11,880	11,163	7,366	121,187
Maryland	216	145	135	134	130	134	104	106	134	134	129	139	1,640
Missouri	418	395	374	375	377	370	375	377	373	370	373	374	4,551
Montana:													
Bituminous	604	619	630	617	677	726	644	705	685	720	663	609	7,899
Lignite	24	25	26	25	28	30	26	29	28	29	27	25	322
Total	628	644	656	642	705	756	670	734	713	749	690	634	8,221
New Mexico	412	647	750	660	774	785	687	673	636	664	775	785	8,248
North Dakota (lignite)	595	640	526	455	550	532	542	548	536	571	587	550	6,632
Ohio	3,710	4,242	5,386	4,358	4,574	4,262	3,444	4,628	4,198	4,458	4,047	3,660	50,967
Oklahoma	240	247	275	228	223	216	187	182	200	202	223	201	2,624
Pennsylvania	6,811	6,691	7,224	6,434	6,850	5,646	4,539	6,651	6,181	6,501	6,436	5,975	75,939
Tennessee	915	913	933	955	954	972	925	924	967	931	928	943	11,260
Texas	315	295	310	300	320	320	350	370	360	375	370	360	4,045
Utah	398	360	408	410	408	406	386	406	408	400	404	408	4,802
Virginia	2,775	2,630	2,950	2,906	3,150	3,255	2,670	3,103	2,691	2,693	2,646	2,559	34,028
Washington	130	203	5	271	363	320	219	231	291	247	174	180	2,634
West Virginia	10,986	10,621	11,825	10,543	11,232	10,615	7,253	10,504	9,914	9,729	10,703	9,818	123,743
Wyoming	814	838	876	864	928	978	915	935	905	920	975	980	10,928
Total [2]	49,680	49,112	54,438	49,814	52,879	50,083	40,964	52,169	49,374	51,671	50,297	44,904	595,386

[1] Figures are based principally upon railroad carloadings and river shipments supplemented by direct reports from certain local sources. These estimates include coal both shipped by truck, and used at the mines, and the totals represent output for all mines producing 1,000 tons or more per year.

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

Table 10.—Number and production of bituminous coal and lignite mines, in 1972, by State, size of output, and type of mining

(Thousand short tons)

State	500,000 tons and over		200,000 to 500,000 tons		100,000 to 200,000 tons		50,000 to 100,000 tons		10,000 to 50,000 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	5	5,659	4	1,519	2	300	--	--	4	77	9	33	24	7,588
Strip	6	5,213	11	3,047	18	2,622	16	1,181	37	1,058	13	55	101	13,177
Auger	--	--	--	--	--	--	--	--	1	49	--	--	1	49
Total	11	10,873	15	4,566	20	2,922	16	1,181	42	1,184	22	88	126	20,814
Alaska:														
Strip	1	668	--	--	--	--	--	--	--	--	--	--	1	668
Arizona:														
Strip	1	2,954	--	--	--	--	--	--	--	--	--	--	1	2,954
Arkansas:														
Underground	--	--	--	--	--	--	--	--	--	--	1	8	1	8
Strip	--	--	--	--	2	248	1	84	2	81	2	7	7	420
Total	--	--	--	--	2	248	1	84	2	81	3	15	8	428
Colorado:														
Underground	1	616	6	1,682	3	442	2	146	7	146	8	36	27	3,070
Strip	3	2,198	--	--	1	122	1	93	2	36	1	4	8	2,452
Total	4	2,814	6	1,682	4	564	3	239	9	182	9	40	35	5,522
Illinois:														
Underground	20	31,358	--	--	3	300	--	--	3	63	--	--	26	31,721
Strip	19	32,031	2	979	3	482	3	246	4	57	2	7	33	33,802
Total	39	63,389	2	979	6	782	3	246	7	120	2	7	59	65,523
Indiana:														
Underground	1	950	1	306	1	104	1	85	--	--	--	--	4	1,446
Strip	12	23,172	1	288	2	273	7	506	9	240	5	26	36	24,503
Total	13	24,122	2	594	3	377	8	591	9	240	5	26	40	25,949
Iowa:														
Underground	--	--	1	239	1	113	--	--	--	--	--	--	2	352
Strip	--	--	--	--	--	--	6	419	3	79	--	--	9	499
Total	--	--	1	239	1	113	6	419	3	79	--	--	11	851

Kansas:														
Strip	1	820	1	205	1	197	--	--	--	--	1	6	4	1,227
Kentucky:														
Underground	29	27,437	29	9,770	51	7,200	65	4,390	285	6,595	238	1,102	697	56,494
Strip	22	32,391	22	7,020	51	6,837	80	5,515	225	3,219	117	794	517	55,776
Auger	--	--	3	1,391	10	1,410	27	1,837	86	3,422	118	857	244	8,917
Total	51	59,828	54	18,181	112	15,447	172	11,742	596	13,236	473	2,753	1,458	121,187
Maryland:														
Underground	--	--	--	--	1	100	--	--	1	28	3	13	5	141
Strip	--	--	--	--	3	407	8	529	18	437	12	62	41	1,435
Auger	--	--	--	--	--	--	--	--	1	21	8	43	9	65
Total [1]	--	--	--	--	4	507	8	529	20	486	23	118	55	1,640
Missouri:														
Strip	3	3,054	3	1,258	2	208	--	--	1	22	2	8	11	4,551
Montana:														
Underground	--	--	--	--	--	--	--	--	--	--	3	17	3	17
Strip	3	7,874	1	320	--	--	--	--	--	--	2	10	6	8,204
Total	3	7,874	1	320	--	--	--	--	--	--	5	27	9	8,221
New Mexico:														
Underground	1	1,014	--	--	--	--	--	--	--	--	--	--	1	1,014
Strip	1	6,816	1	397	--	--	--	--	1	17	1	5	4	7,235
Total [1]	2	7,830	1	397	--	--	--	--	1	17	1	5	5	8,248
North Dakota:														
Strip	4	5,426	2	876	2	282	--	--	2	33	4	15	14	6,632
Ohio:														
Underground	14	12,741	8	2,850	2	375	2	160	5	120	4	24	35	16,269
Strip	17	18,742	23	6,815	27	3,420	44	3,067	66	1,704	59	329	236	34,077
Auger	--	--	--	--	1	130	2	102	22	355	10	34	35	621
Total	31	31,483	31	9,665	30	3,925	48	3,329	93	2,179	73	387	306	50,967
Oklahoma:														
Underground	--	--	--	--	--	--	1	80	--	--	1	8	2	88
Strip	2	1,568	1	222	3	452	3	260	2	27	2	7	13	2,536
Total	2	1,568	1	222	3	452	4	340	2	27	3	15	15	2,624
Pennsylvania:														
Underground	40	35,119	27	9,732	20	2,747	12	878	23	535	37	121	159	49,133
Strip	1	662	10	2,629	50	7,022	83	5,795	344	9,455	134	702	622	26,264
Auger	--	--	--	--	--	--	--	--	18	341	37	201	55	542
Total [1]	41	35,782	37	12,361	70	9,769	95	6,673	385	10,331	208	1,024	836	75,939

See footnotes at end of table.

Table 10.—Number and production of bituminous coal and lignite mines, in 1972, by State, size of output, and type of mining—Continued

(Thousand short tons)

State	500,000 tons and over		200,000 to 500,000 tons		100,000 to 200,000 tons		50,000 to 100,000 tons		10,000 to 50,000 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
Tennessee:														
Underground	1	1,171	4	1,029	10	1,227	18	1,257	46	1,029	29	153	108	5,866
Strip	--	--	3	857	12	1,703	20	1,353	43	1,133	16	67	94	5,113
Auger	--	--	--	--	--	--	2	135	6	142	1	3	9	281
Total	1	1,171	7	1,886	22	2,930	40	2,745	95	2,304	46	223	211	11,260
Texas:														
Strip	2	3,805	1	240	--	--	--	--	--	--	--	--	3	4,045
Utah:														
Underground	1	961	10	2,918	4	636	2	183	3	66	1	6	21	4,770
Strip	--	--	--	--	--	--	--	--	1	32	--	--	1	32
Total	1	961	10	2,918	4	636	2	183	4	98	1	6	22	4,802
Virginia:														
Underground	7	6,718	20	7,438	15	2,397	30	2,401	160	4,559	95	480	327	23,993
Strip	--	--	3	952	7	1,032	33	1,825	140	3,888	61	238	244	7,935
Auger	--	--	--	--	2	294	5	357	56	1,176	59	273	122	2,100
Total [1]	7	6,718	23	8,390	24	3,723	68	4,583	356	9,623	215	991	693	34,028
Washington:														
Underground	--	--	--	--	--	--	--	--	1	29	--	--	1	29
Strip	1	2,597	--	--	--	--	--	--	--	--	1	9	2	2,606
Total [1]	1	2,597	--	--	--	--	--	--	1	29	1	9	3	2,634
West Virginia:														
Underground	49	49,735	92	30,084	61	9,515	70	5,716	161	5,717	115	895	548	101,662
Strip	4	3,110	18	4,626	38	4,932	64	4,736	114	1,377	50	320	288	19,101
Auger	--	--	--	--	7	874	8	640	40	1,290	44	175	99	2,979
Total [1]	53	52,845	110	34,710	106	15,321	142	11,092	315	8,384	209	1,390	935	123,743
Wyoming:														
Underground	--	--	1	335	--	--	1	96	--	--	3	10	5	442
Strip	8	10,022	1	289	1	120	--	--	2	53	1	2	13	10,487
Total [1]	8	10,022	2	624	1	120	1	96	2	53	4	12	18	10,928
United States:														
Underground	169	173,479	203	67,902	174	25,456	204	15,392	699	18,964	547	2,906	1,996	304,103
Strip	111	163,124	104	31,020	223	30,359	369	25,609	1,016	22,948	486	2,673	2,309	275,730
Auger	--	--	3	1,391	20	2,708	44	3,071	230	6,796	277	1,586	574	15,554
Total [1]	280	336,604	310	100,313	417	58,523	617	44,072	1,945	48,708	1,310	7,165	4,879	595,386

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

Table 11.—Production, shipments, and value at bituminous coal and lignite mines, in 1972, by State and county

(Thousand short tons)

State and county	Production						Shipments					Average value per ton [4]
	Underground		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						
Alabama:												
Bibb	--	--	1	898	--	--	898	--	--	--	898	$6.36
Blount	--	--	4	260	--	--	199	61	--	--	260	8.28
Cullman	--	--	5	554	--	--	221	333	--	--	554	6.21
De Kalb	--	--	1	20	--	--	--	20	--	--	20	W
Etowah	--	--	1	16	--	--	16	--	--	--	16	7.38
Jackson	--	--	2	1,279	--	--	1,254	25	--	--	1,279	W
Jefferson	16	5,222	34	4,167	1	49	8,136	1,000	297	6	9,438	10.76
Marion	4	39	5	348	--	--	304	84	--	--	387	7.85
Shelby	1	2	2	100	--	--	--	101	--	--	101	5.16
Tuscaloosa	--	--	8	2,208	--	--	2,108	100	--	--	2,208	7.43
Walker	3	2,326	35	3,138	--	--	3,039	1,231	1,193	--	5,464	10.76
Winston	--	--	3	188	--	--	32	156	--	--	188	11.03
Total or average [3]	24	7,588	101	13,177	1	49	16,208	3,110	1,490	6	20,814	9.63
Alaska	--	--	1	668	--	--	556	112	--	--	668	W
Arizona:												
Navajo	--	--	1	2,954	--	--	--	--	--	2,954	2,954	W
Arkansas:												
Franklin	--	--	1	84	--	--	84	--	--	--	84	W
Johnson	1	8	3	184	--	--	192	--	--	--	192	13.80
Logan	--	--	1	4	--	--	--	4	--	--	4	10.90
Sebastian	--	--	2	148	--	--	147	[5]	--	--	148	W
Total or average [3]	1	8	7	420	--	--	423	5	--	--	428	10.93

See footnotes at end of table.

Table 11.—Production, shipments, and value at bituminous coal and lignite mines, in 1972, by State and county—Continued

(Thousand short tons)

State and county	Production						Shipments					Average value per ton [4]
	Underground		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						
Colorado:												
Delta	3	98	--	--	--	--	90	8	--	(5)	98	$11.53
Fremont	5	78	2	136	--	--	2	213	--	(5)	214	4.88
Garfield	1	1	--	--	--	--	--	1	--	--	1	W
Gunnison	4	719	--	--	--	--	690	28	--	--	719	9.59
Huerfano	1	4	--	--	--	--	--	4	--	--	4	7.51
La Plata	1	7	1	4	--	--	--	11	--	--	11	4.30
Las Animas	1	616	--	--	--	--	616	--	--	--	616	W
Mesa	1	11	--	--	--	--	--	--	11	--	11	W
Moffat	2	294	--	--	--	--	260	34	--	(5)	294	6.01
Montrose	--	--	1	93	--	--	--	93	--	--	93	W
Pitkin	3	649	--	--	--	--	649	--	--	--	649	W
Rio Blanco	1	5	--	--	--	--	--	5	--	--	5	W
Routt	1	12	4	2,219	--	--	1,642	13	575	(5)	2,231	4.03
Weld	3	575	--	--	--	--	272	301	--	1	575	5.17
Total or average [3]	27	3,070	8	2,452	--	--	4,221	712	587	2	5,522	6.45
Illinois:												
Christian	1	4,693	--	--	--	--	407	425	3,858	4	4,693	W
Douglas	1	1,239	--	--	--	--	345	894	--	(5)	1,239	W
Franklin	4	7,270	--	--	--	--	7,230	40	--	1	7,270	6.29
Fulton	--	--	4	4,375	--	--	3,925	448	--	1	4,375	6.33
Gallatin	2	1,746	1	642	--	--	2,388	--	--	--	2,388	6.87
Jackson	--	--	2	142	--	--	117	25	--	--	142	6.00
Jefferson	3	6,428	1	945	--	--	7,229	125	--	20	7,373	8.02
Johnson	--	--	1	4	--	--	1	3	--	--	4	W
Kankakee	--	--	1	519	--	--	121	398	--	--	519	W
Knox	--	--	1	1,519	--	--	1,424	--	--	94	1,519	W
Macoupin	1	1,983	--	--	--	--	1,983	(5)	--	--	1,983	W
Mercer	1	30	1	11	--	--	11	30	--	--	40	W
Montgomery	1	1,991	--	--	--	--	--	207	1,784	--	1,991	W
Peoria	--	--	3	2,515	--	--	1,793	721	--	(5)	2,515	5.72
Perry	--	--	4	11,177	--	--	11,171	(5)	--	6	11,177	4.87
Pope	--	--	1	3	--	--	--	3	--	--	3	W
Randolph	1	823	2	3,041	--	--	3,641	223	--	(5)	3,864	5.89
St. Clair	3	2,438	1	4,997	--	--	2,341	5,094	--	--	7,435	5.06
Saline	3	1,237	5	1,213	--	--	2,364	80	--	5	2,450	7.37
Stark	--	--	1	502	--	--	502	--	--	(5)	502	W
Vermilion	1	16	--	--	--	--	4	12	--	--	16	W
Williamson	4	1,826	4	2,197	--	--	3,768	248	--	6	4,023	7.31
Total or average [3]	26	31,721	33	33,802	--	--	50,766	8,976	5,642	139	65,523	6.14

Indiana:												
Clay	--	--	6	1,290	--	--	184	1,106	--	--	1,290	6.31
Fountain	--	--	1	23	--	--	--	23	--	(5)	23	W
Gibson	1	950	--	--	--	--	950	--	--	--	950	W
Greene	--	--	4	2,728	--	--	2,498	230	--	--	2,728	5.60
Parke	--	--	1	5	--	--	--	5	--	--	5	W
Pike	1	104	11	5,880	--	--	4,900	796	288	(5)	5,984	5.79
Spencer	--	--	3	234	--	--	26	208	--	--	234	4.02
Sullivan	1	306	2	3,198	--	--	2,791	712	--	(5)	3,504	W
Vermillion	--	--	1	2,253	--	--	2,220	33	--	--	2,253	W
Vigo	1	85	--	--	--	--	--	85	--	--	85	W
Warrick	--	--	7	8,893	--	--	6,220	583	2,087	3	8,893	5.25
Total or average [3]	4	1,446	36	24,503	--	--	19,790	3,781	2,374	4	25,949	5.58
Iowa:												
Lucas	1	113	--	--	--	--	103	--	--	10	113	4.80
Mahaska	--	--	5	306	--	--	181	125	--	--	306	4.73
Marion	--	--	3	173	--	--	160	13	--	--	173	5.26
Monroe	1	239	1	19	--	--	19	239	--	--	258	4.79
Total or average [3]	2	352	9	499	--	--	463	377	--	10	851	4.87
Kansas:												
Cherokee	--	--	2	825	--	--	804	20	--	2	825	6.10
Crawford	--	--	2	402	--	--	336	65	--	(5)	402	6.96
Total or average [3]	--	--	4	1,227	--	--	1,140	85	--	2	1,227	6.39
Kentucky:												
Eastern:												
Bell	15	700	27	2,666	15	338	3,597	106	--	--	3,704	6.56
Boyd	--	--	5	178	2	36	--	213	--	--	213	6.22
Breathitt	--	--	32	4,260	16	1,867	6,125	2	--	--	6,127	6.50
Carter	--	--	13	280	3	54	302	32	--	--	334	5.81
Clay	11	135	11	234	5	84	333	120	--	--	453	6.06
Clinton	--	--	1	62	--	--	--	62	--	--	62	W
Elliott	--	--	1	53	--	--	53	--	--	--	53	W
Floyd	107	2,520	20	1,239	14	507	3,867	398	--	--	4,266	5.96
Greenup	--	--	2	32	2	14	--	45	--	--	45	6.00
Harlan	67	7,375	36	1,328	31	705	8,284	1,095	--	30	9,408	10.08
Jackson	--	--	2	41	1	11	37	15	--	--	52	W
Johnson	12	208	17	1,624	5	334	2,109	57	--	--	2,166	5.44
Knott	48	2,746	18	437	13	225	3,197	211	--	--	3,408	7.60
Knox	5	22	24	637	7	119	543	235	--	--	777	6.10
Laurel	--	--	11	407	5	58	451	15	--	--	466	6.65
Lawrence	--	--	6	247	4	71	225	93	--	--	318	6.07
Lee	1	17	--	--	--	--	9	6	--	1	17	W
Leslie	12	1,325	18	362	9	182	1,669	200	--	--	1,869	7.51
Letcher	75	2,849	47	1,486	30	921	4,864	388	--	4	5,256	7.58
McCreary	5	917	3	106	1	12	1,017	18	--	--	1,035	7.78
Magoffin	2	10	7	416	3	12	417	21	--	--	438	5.34
Martin	12	1,750	14	675	4	121	2,533	13	--	--	2,546	6.98

See footnotes at end of table.

Table 11.—Production, shipments, and value at bituminous coal and lignite mines, in 1972, by State and county—Continued

(Thousand short tons)

State and county	Production: Underground: Number of mines	Underground: Quantity	Strip: Number of mines	Strip: Quantity	Auger: Number of mines	Auger: Quantity	Shipments: Rail or water [1]	Truck	Mine-mouth generating plants	All other [2]	Total [3]	Average value per ton [4]
Kentucky—Continued												
Eastern—Continued												
Morgan	--	--	3	150	--	--	141	9	--	--	150	$9.45
Owsley	--	--	1	28	1	13	--	41	--	--	41	W
Perry	37	2,522	34	1,572	18	955	4,927	122	--	--	5,049	7.28
Pike	251	14,680	65	2,430	42	2,020	18,079	1,049	--	2	19,130	9.53
Pulaski	2	17	3	447	--	--	179	280	--	5	464	6.34
Rockcastle	--	--	1	20	--	--	--	20	--	--	20	W
Wayne	--	--	3	11	1	2	6	7	--	--	13	6.00
Whitley	8	152	21	707	7	119	914	63	--	--	977	6.27
Total or average [3]	670	37,946	446	22,132	239	8,779	63,879	4,937	--	42	68,858	8.01
Kentucky:												
Western:												
Butler	2	71	4	93	1	39	125	71	--	7	203	5.27
Christian	--	--	3	80	--	--	77	3	--	--	80	4.81
Daviess	--	--	2	1,012	--	--	382	--	629	--	1,012	W
Edmonson	--	--	1	160	--	--	160	--	--	--	160	W
Hancock	--	--	1	38	--	--	38	(5)	--	--	38	W
Henderson	1	87	--	--	--	--	8	79	--	--	87	5.97
Hopkins	10	5,508	21	5,163	2	52	10,513	211	--	--	10,723	6.05
McLean	--	--	3	1,106	--	--	1,106	--	--	--	1,106	4.37
Muhlenberg	6	5,101	16	20,938	2	46	17,642	137	8,288	19	26,086	4.79
Ohio	1	1,536	19	4,933	--	--	6,229	240	--	--	6,469	4.99
Union	6	4,944	--	--	--	--	4,944	--	--	--	4,944	5.56
Webster	1	1,300	1	121	--	--	1,421	--	--	--	1,421	7.15
Total or average [3]	27	18,547	71	33,645	5	137	42,645	742	8,917	26	52,330	5.23
Total or average Kentucky [3]	697	56,494	517	55,776	244	8,917	106,524	5,679	8,917	68	121,187	6.81
Maryland:												
Allegany	1	7	17	504	3	9	196	324	--	--	520	5.38
Garrett	4	134	24	930	6	55	490	630	--	--	1,120	5.50
Total or average [3]	5	141	41	1,434	9	64	687	954	--	--	1,640	5.46

Missouri:												
Barton	--	--	1	585	--	--	--	--	585	--	585	W
Bates	--	--	1	103	--	--	--	--	103	--	103	W
Boone	--	--	1	373	--	--	204	169	--	--	373	W
Callaway	--	--	1	22	--	--	--	22	--	--	22	W
Henry	--	--	2	1,898	--	--	431	7	1,459	--	1,898	W
Macon	--	--	1	1,010	--	--	1,010	--	--	--	1,010	W
Putnam	--	--	1	105	--	--	105	--	--	--	105	W
Randolph	--	--	1	446	--	--	--	--	446	--	446	W
Vernon	--	--	2	8	--	--	--	8	--	--	8	W
Total or average [3]	--	--	11	4,551	--	--	1,751	207	2,593	--	4,551	5.20
Montana (bituminous):												
Big Horn	--	--	1	772	--	--	772	--	--	--	772	W
Musselshell	3	17	1	9	--	--	--	25	--	--	25	W
Rosebud	--	--	2	7,102	--	--	7,101	1	--	--	7,102	W
Total or average [3]	3	17	4	7,882	--	--	7,873	26	--	--	7,899	2.01
Montana (lignite):												
Powder River	--	--	1	2	--	--	--	2	--	--	2	W
Richland	--	--	1	320	--	--	320	(5)	--	--	320	W
Total or average [3]	--	--	2	322	--	--	320	2	--	--	322	2.45
Total or average Montana [3]	3	17	6	8,204	--	--	8,193	28	--	--	8,221	2.03
New Mexico:												
Colfax	1	1,014	1	17	--	--	1,030	--	--	--	1,030	W
McKinley	--	--	2	402	--	--	397	5	--	--	402	W
San Juan	--	--	1	6,816	--	--	--	--	6,816	--	6,816	W
Total or average [3]	1	1,014	4	7,235	--	--	1,427	5	6,816	--	8,248	3.61
North Dakota (lignite):												
Adams	--	--	2	19	--	--	--	19	--	--	19	W
Bowman	--	--	1	166	--	--	118	--	--	48	166	W
Burke	--	--	2	487	--	--	457	30	--	--	487	W
Grant	--	--	1	3	--	--	--	3	--	--	3	W
McLean	--	--	1	16	--	--	--	16	--	--	16	W
Mercer	--	--	3	3,148	--	--	2,452	13	682	(5)	3,148	W
Oliver	--	--	1	2,278	--	--	--	--	2,278	--	2,278	W
Stark	--	--	1	117	--	--	--	117	--	--	117	W
Ward	--	--	1	393	--	--	196	--	196	--	393	W
Williams	--	--	1	5	--	--	--	5	--	--	5	W
Total or average [3]	--	--	14	6,632	--	--	3,224	203	3,157	48	6,632	2.02

See footnotes at end of table.

Table 11.—Production, shipments, and value at bituminous coal and lignite mines, in 1972, by State and county—Continued

(Thousand short tons)

State and county	Production						Shipments					Average value per ton [4]
	Underground		Strip		Auger							
	Number of mines	Quantity	Number of mines	Quantity	Number of mines	Quantity	Rail or water [1]	Truck	Mine-mouth generating plants	All other [2]	Total [3]	
Ohio:												
Athens	--	--	1	1	--	--	--	1	--	--	1	W
Belmont	9	7,711	29	9,012	3	53	16,170	606	--	(5)	16,776	$6.26
Carroll	--	--	6	420	2	6	297	129	--	--	426	5.12
Columbiana	3	29	24	862	4	138	156	872	--	--	1,028	5.00
Coshocton	2	469	7	1,922	3	180	346	993	1,231	--	2,570	7.07
Gallia	--	--	3	90	--	--	56	34	--	--	90	3.35
Guernsey	1	369	6	772	--	--	904	135	102	--	1,141	5.33
Harrison	5	3,511	19	4,208	3	66	7,144	641	--	--	7,785	6.40
Hocking	--	--	7	165	1	2	--	167	--	--	167	4.73
Holmes	--	--	6	753	--	--	--	753	--	--	753	4.51
Jackson	4	327	9	1,065	2	17	798	612	--	--	1,409	4.19
Jefferson	2	852	33	4,819	7	105	3,448	2,167	162	--	5,777	5.68
Lawrence	--	--	2	48	--	--	21	26	--	2	48	W
Mahoning	--	--	7	387	1	1	--	388	--	--	388	W
Meigs	1	29	--	--	--	--	--	29	--	--	29	8.00
Monroe	1	691	--	--	--	--	691	--	--	--	691	W
Morgan	--	--	2	691	--	--	6	3	683	--	691	W
Muskingum	1	42	7	4,142	1	8	379	459	3,354	--	4,192	6.02
Noble	--	--	4	957	--	--	254	567	136	--	957	4.76
Perry	4	2,171	12	745	2	9	1,766	1,158	--	--	2,925	5.68
Stark	--	--	11	346	3	9	--	355	--	--	355	4.61
Tuscarawas	2	70	30	1,852	3	27	292	1,656	--	--	1,948	4.94
Vinton	--	--	8	581	--	--	27	554	--	--	581	5.44
Washington	--	--	2	206	--	--	57	149	--	--	206	W
Wayne	--	--	1	31	--	--	--	31	--	--	31	W
Total or average [3]	35	16,269	236	34,077	35	621	32,811	12,486	5,667	2	50,967	5.96
Oklahoma:												
Craig	--	--	2	825	--	--	745	80	--	1	825	W
Haskell	1	8	4	413	--	--	421	--	--	--	421	W
Le Flore	1	80	--	--	--	--	80	--	--	--	80	W
Muskogee	--	--	2	159	--	--	157	2	--	--	159	W
Nowata	--	--	1	85	--	--	85	--	--	--	85	W
Pittsburg	--	--	1	126	--	--	126	--	--	--	126	W
Rogers	--	--	3	928	--	--	913	15	--	--	928	W
Total or average [3]	2	88	13	2,536	--	--	2,527	97	--	1	2,624	7.28

Pennsylvania:												
Allegheny	7	3,780	10	771	--	--	2,927	1,623	--	1	4,551	9.87
Armstrong	19	5,241	59	2,539	11	96	1,900	2,495	3,288	194	7,876	7.11
Beaver	1	130	3	122	4	32	--	285	--	--	285	7.44
Bedford	1	1	--	--	--	--	--	1	--	--	1	W
Butler	4	565	31	977	2	54	934	659	--	4	1,596	6.09
Cambria	20	6,401	21	968	--	--	6,361	1,000	--	7	7,368	12.92
Centre	1	448	13	618	--	--	716	350	--	--	1,067	7.62
Clarion	--	--	62	4,281	--	--	3,434	847	--	--	4,281	7.27
Clearfield	10	1,094	97	4,568	6	55	3,872	1,712	83	51	5,718	7.15
Clinton	--	--	11	240	--	--	198	42	--	--	240	6.71
Elk	--	--	14	336	4	31	168	199	--	--	367	6.60
Fayette	3	780	50	1,095	1	18	1,439	452	--	2	1,893	8.08
Fulton	--	--	1	1	--	--	--	1	--	--	1	W
Greene	15	8,158	26	950	--	--	8,204	886	--	18	9,109	10.99
Indiana	29	6,767	49	1,624	8	66	2,834	1,136	4,477	10	8,456	8.59
Jefferson	5	48	39	1,267	5	61	1,104	272	--	(5)	1,376	7.35
Lawrence	--	--	16	525	4	15	--	506	--	33	540	6.21
Lycoming	--	--	3	127	--	--	--	127	--	--	127	W
Mercer	--	--	3	319	--	--	173	91	51	3	319	W
Somerset	20	1,382	64	2,310	8	86	2,207	1,480	--	90	3,777	6.80
Tioga	--	--	1	662	--	--	--	662	--	--	662	W
Venango	--	--	9	361	--	--	165	196	--	--	361	5.13
Washington	17	12,476	13	1,085	2	29	12,191	1,397	--	2	13,589	10.74
Westmoreland	7	1,862	27	518	--	--	1,578	604	192	5	2,380	8.72
Total or average [3]	159	49,133	622	26,264	55	542	50,404	17,024	8,091	420	75,939	9.14
Tennessee:												
Anderson	25	1,348	22	1,318	5	120	720	1,999	W	W	2,786	7.40
Bledsoe	--	--	2	W	--	--	36	45	--	--	81	W
Campbell	20	885	13	935	2	135	823	1,132	--	--	1,956	7.46
Claiborne	5	1,471	10	907	--	--	2,243	135	--	--	2,378	7.08
Cumberland	2	11	3	17	--	--	--	28	--	--	28	7.12
Fentress	2	25	7	387	--	--	230	182	--	--	412	6.34
Grundy	--	--	6	182	--	--	147	34	--	--	182	7.31
Hamilton	2	W	1	W	--	--	--	W	--	--	W	W
Marion	17	644	3	33	--	--	602	74	--	--	676	6.89
Morgan	6	88	8	407	1	12	11	496	--	--	507	7.10
Overton	--	--	1	W	--	--	--	W	--	--	W	W
Putnam	1	W	--	--	--	--	--	W	W	--	W	W
Rhea	2	W	--	--	--	--	--	W	--	--	W	W
Roane	--	--	1	W	--	--	W	--	--	--	W	W
Scott	18	991	14	440	1	14	1,337	109	--	--	1,445	7.63
Sequatchie	5	W	1	W	--	--	W	W	--	W	W	W
Van Buren	1	W	2	W	--	--	W	W	--	--	W	W
White	2	95	--	--	--	--	80	15	--	--	95	7.84
Total or average [3]	108	5,866	94	5,113	9	281	6,600	4,510	122	28	11,260	7.23

See footnotes at end of table.

Table 11.—Production, shipments, and value at bituminous coal and lignite mines, in 1972, by State and county—Continued

(Thousand short tons)

State and county	Production						Shipments					Average value per ton [4]
	Underground		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						
Texas (lignite):												
Freestone	--	--	1	W	--	--	--	--	W	--	W	W
Harrison	--	--	1	W	--	--	--	W	--	--	W	W
Milan	--	--	1	W	--	--	--	--	W	--	W	W
Total or average [3]	--	--	3	4,045	--	--	--	W	W	--	4,045	W
Utah:												
Carbon	11	3,012	1	32	--	--	2,746	296	--	2	3,044	$10.13
Emery	8	1,569	--	--	--	--	1,085	484	--	--	1,569	6.90
Sevier	1	184	--	--	--	--	46	138	--	--	184	6.50
Summit	1	6	--	--	--	--	--	6	--	--	6	5.50
Total or average [3]	21	4,770	1	32	--	--	3,877	923	--	2	4,802	8.93
Virginia:												
Buchanan	215	11,001	48	1,356	47	845	12,692	510	--	--	13,202	12.04
Dickenson	34	4,460	37	1,542	16	233	6,194	41	--	--	6,235	9.72
Lee	20	683	17	220	10	132	945	91	--	--	1,036	7.33
Russell	4	1,817	12	778	10	117	2,670	42	--	--	2,712	9.98
Scott	2	11	--	--	--	--	4	--	--	7	11	8.50
Tazewell	13	1,314	11	456	5	20	1,602	186	--	3	1,791	8.72
Wise	39	4,706	119	3,582	34	752	8,855	183	--	3	9,041	8.20
Total or average [3]	327	23,993	244	7,935	122	2,100	32,963	1,052	--	13	34,028	10.11
Washington:												
King	1	29	--	--	--	--	--	29	--	--	29	16.40
Lewis	--	--	2	2,606	--	--	--	9	2,597	--	2,606	6.51
Total or average [3]	1	29	2	2,606	--	--	--	38	2,597	--	2,634	6.61
West Virginia:												
Barbour	12	1,306	17	2,427	2	89	3,372	445	--	6	3,823	8.81
Boone	40	8,852	21	1,676	14	280	10,450	352	--	7	10,809	9.07
Braxton	1	2	--	--	--	--	--	2	--	--	2	8.41
Brooke	2	682	6	209	1	10	290	16	595	(5)	901	7.88
Clay	1	25	1	4	--	--	29	--	--	--	29	7.29
Fayette	24	2,868	13	587	6	47	3,391	109	1	1	3,502	10.88
Gilmer	--	--	1	49	--	--	49	--	--	--	49	6.00
Grant	3	1,314	8	487	--	--	1,563	163	31	44	1,801	6.77
Greenbrier	4	106	12	451	--	--	549	8	--	--	557	12.31
Harrison	10	3,971	18	1,267	3	94	4,896	15	421	--	5,332	7.58
Kanawha	41	6,961	23	2,689	25	1,025	9,568	1,104	--	2	10,675	8.67
Lewis	--	--	7	264	1	60	299	25	--	--	324	6.89

Logan	55	8,449	12	778	14	539	9,690	74	--	2	9,766	11.35
McDowell	109	13,336	17	809	4	53	13,932	168	--	97	14,198	15.28
Marion	7	7,135	3	89	--	--	7,069	93	--	61	7,224	8.71
Marshall	4	6,389	--	--	--	--	2,264	69	4,055	--	6,389	6.88
Mason	1	181	--	--	--	--	--	--	181	--	181	8.24
Mercer	4	1,023	3	57	2	34	1,113	--	--	--	1,113	14.16
Mineral	1	106	5	233	--	--	173	167	--	--	340	5.57
Mingo	32	2,604	11	740	10	439	3,533	250	--	--	3,783	9.07
Monongalia	17	11,918	12	611	--	--	12,255	190	76	8	12,529	7.60
Nicholas	40	4,625	18	1,324	5	74	5,918	106	--	--	6,024	10.11
Ohio	2	2,204	--	--	--	--	2,024	129	--	50	2,204	9.07
Preston	12	696	26	829	--	--	676	846	--	3	1,525	6.09
Raleigh	30	5,503	13	1,113	6	186	6,579	218	--	5	6,802	13.99
Randolph	9	249	11	673	--	--	872	49	--	(5)	922	7.71
Taylor	--	--	5	280	--	--	269	11	--	--	280	7.00
Tucker	--	--	2	146	--	--	146	--	--	--	146	10.99
Upshur	5	286	10	636	--	--	881	41	--	--	922	7.09
Wayne	2	376	--	--	--	--	369	7	--	--	376	9.25
Webster	9	95	3	17	1	3	79	36	--	--	114	8.97
Wyoming	71	10,400	10	654	5	47	10,835	256	--	11	11,102	13.92
Total or average [3]	548	101,662	288	19,101	99	2,979	113,136	4,948	5,361	299	123,743	10.31
Wyoming:												
Campbell	--	--	2	656	--	--	447	10	198	1	656	W
Carbon	1	335	4	3,843	--	--	4,154	24	--	--	4,179	3.89
Converse	--	--	2	2,622	--	--	--	--	2,618	4	2,622	3.46
Hot Springs	2	6	--	--	--	--	(5)	5	--	--	6	10.21
Lincoln	--	--	2	2,103	--	--	259	--	1,844	(5)	2,103	W
Sheridan	--	--	2	974	--	--	934	40	--	--	974	W
Sweetwater	2	101	1	289	--	--	355	1	--	34	389	4.99
Total or average [3]	5	442	13	10,487	--	--	6,149	80	4,660	39	10,928	3.74
Total or average United States [3]	1,996	304,103	2,309	275,730	574	15,554	463,839	65,633	61,878	4,036	595,386	7.66

W Withheld to avoid disclosing individual company 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 received or charged for coal f.o.b. mine. Includes a value for coal not sold but used by producers, such as mine fuel and coal coked, as estimated by producers at average prices that might have been received if such coal had been sold commercially.

[5] Less than 500 tons.

Table 12.—Number of mines, men working daily, days active, and output per man per day at bituminous coal and lignite mines in the United States, in 1972, by State and county

State and county	Number of mines			Average number of men working daily				Average number of days worked			Average tons per man per day			
	Underground	Strip	Auger	Underground	Strip	Auger	Total	Underground	Strip	Auger	Underground	Strip	Auger	Total
Alabama:														
Bibb	--	1	--	--	123	--	123	--	306	--	--	23.83	--	23.83
Blount	--	4	--	--	76	--	76	--	279	--	--	12.26	--	12.26
Cullman	--	5	--	--	88	--	88	--	208	--	--	30.44	--	30.44
De Kalb	--	1	--	--	12	--	12	--	61	--	--	27.59	--	27.59
Etowah	--	1	--	--	17	--	17	--	78	--	--	12.12	--	12.12
Jackson	--	2	--	--	156	--	156	--	229	--	--	35.86	--	35.86
Jefferson	16	34	1	2,367	526	3	2,896	243	275	240	9.08	28.80	60.01	13.10
Marion	4	5	--	30	67	--	97	136	250	--	9.50	20.81	--	18.59
Shelby	1	2	--	2	20	--	22	240	180	--	4.00	27.59	--	25.24
Tuscaloosa	--	8	--	--	241	--	241	--	279	--	--	32.79	--	32.79
Walker	3	35	--	810	493	--	1,303	256	256	--	11.22	24.88	--	16.39
Winston	--	3	--	--	31	--	31	--	223	--	--	27.59	--	27.59
Total or average	24	101	1	3,209	1,850	3	5,062	245	260	240	9.64	27.44	60.01	16.42
Alaska	--	1	--	--	83	--	83	--	310	--	--	25.96	--	25.96
Arizona:														
Navajo	--	1	--	--	103	--	103	--	220	--	--	130.35	--	130.35
Arkansas:														
Franklin	--	1	--	--	24	--	24	--	196	--	--	17.89	--	17.89
Johnson	1	3	--	34	59	--	93	51	242	--	4.63	12.86	--	11.97
Logan	--	1	--	--	9	--	9	--	50	--	--	9.53	--	9.53
Sebastian	--	2	--	--	39	--	39	--	318	--	--	11.89	--	11.89
Total or average	1	7	--	34	131	--	165	51	243	--	4.63	13.18	--	12.74
Colorado:														
Delta	3	--	--	43	--	--	43	177	--	--	12.78	--	--	12.78
Fremont	5	2	--	21	13	--	34	222	262	--	16.53	40.95	--	26.64
Garfield	1	--	--	1	--	--	1	231	--	--	5.92	--	--	5.92
Gunnison	4	--	--	233	--	--	233	218	--	--	14.15	--	--	14.15
Huerfano	1	--	--	6	--	--	6	158	--	--	4.60	--	--	4.60
La Plata	1	1	--	6	5	--	11	248	196	--	4.87	3.70	--	4.40
Las Animas	1	--	--	425	--	--	425	260	--	--	5.58	--	--	5.58
Mesa	1	--	--	6	--	--	6	127	--	--	14.80	--	--	14.80
Moffat	2	--	--	57	--	--	57	214	--	--	24.14	--	--	24.14
Montrose	--	1	--	--	15	--	15	--	302	--	--	20.46	--	20.46
Pitkin	3	--	--	216	--	--	216	272	--	--	11.04	--	--	11.04
Rio Blanco	1	--	--	3	--	--	3	182	--	--	8.34	--	--	8.34
Routt	1	4	--	4	109	--	113	216	306	--	13.51	66.54	--	65.20
Weld	3	--	--	164	--	--	164	223	--	--	15.74	--	--	15.74
Total or average	27	8	--	1,185	142	--	1,327	241	297	--	10.74	58.11	--	16.83

Illinois:														
Christian	1	--	--	785	--	--	785	242	--	--	24.71	--	--	24.71
Douglass	1	--	--	202	--	--	202	288	--	--	21.30	--	--	21.30
Franklin	4	--	--	1,363	--	--	1,363	264	--	--	20.20	--	--	20.20
Fulton	--	4	--	--	534	--	534	--	266	--	--	30.82	--	30.82
Gallatin	2	1	--	656	110	--	766	262	284	--	10.16	20.52	--	11.76
Jackson	--	2	--	--	21	--	21	--	154	--	--	43.98	--	43.98
Jefferson	3	1	--	1,422	57	--	1,479	262	259	--	17.25	84.15	--	19.03
Johnson	--	1	--	--	2	--	2	--	94	--	--	21.26	--	21.26
Kankakee	--	1	--	--	142	--	142	--	193	--	--	18.93	--	18.93
Knox	--	1	--	--	146	--	146	--	244	--	--	42.63	--	42.63
Macoupin	1	--	--	407	--	--	407	257	--	--	18.95	--	--	18.95
Mercer	1	1	--	10	10	--	20	245	29	--	12.11	36.63	--	14.70
Montgomery	1	--	--	375	--	--	375	229	--	--	23.18	--	--	23.18
Peoria	--	3	--	--	288	--	288	--	291	--	--	30.01	--	30.01
Perry	--	4	--	--	704	--	704	--	319	--	--	49.80	--	49.80
Pope	--	1	--	--	2	--	2	--	61	--	--	26.27	--	26.27
Randolph	1	2	--	204	264	--	468	220	321	--	18.31	35.91	--	29.81
St. Clair	3	1	--	632	352	--	984	251	275	--	15.37	51.62	--	29.11
Saline	3	5	--	362	214	--	576	215	285	--	15.88	19.87	--	17.63
Stark	--	1	--	--	100	--	100	--	208	--	--	24.15	--	24.15
Vermilion	1	--	--	27	--	--	27	79	--	--	7.60	--	--	7.60
Williamson	4	4	--	623	310	--	933	234	274	--	12.52	25.86	--	17.43
Total or average	26	33	--	7,068	3,256	--	10,324	251	280	--	17.87	37.09	--	24.39
Indiana:														
Clay	--	6	--	--	174	--	174	--	277	--	--	26.73	--	26.73
Fountain	--	1	--	--	11	--	11	--	155	--	--	13.83	--	13.83
Gibson	1	--	--	205	--	--	205	260	--	--	17.79	--	--	17.79
Greene	--	4	--	--	337	--	337	--	301	--	--	26.87	--	26.87
Parke	--	1	--	--	2	--	2	--	233	--	--	10.60	--	10.60
Pike	1	11	--	16	750	--	766	275	270	--	24.00	29.02	--	28.91
Spencer	--	3	--	--	48	--	48	--	289	--	--	16.90	--	16.90
Sullivan	1	2	--	123	304	--	427	172	278	--	14.43	37.89	--	33.18
Vermillion	--	1	--	--	101	--	101	--	308	--	--	72.43	--	72.43
Vigo	1	--	--	19	--	--	19	233	--	--	19.63	--	--	19.63
Warrick	--	7	--	--	723	--	723	--	279	--	--	44.08	--	44.08
Total or average	4	36	--	363	2,450	--	2,813	230	280	--	17.35	35.74	--	33.75
Iowa:														
Lucas	1	--	--	27	--	--	27	265	--	--	15.94	--	--	15.94
Mahaska	--	5	--	--	47	--	47	--	283	--	--	23.27	--	23.27
Marion	--	3	--	--	32	--	32	--	291	--	--	18.46	--	18.46
Monroe	1	1	--	27	8	--	35	302	125	--	29.77	20.52	--	28.80
Total or average	2	9	--	54	87	--	141	280	270	--	23.29	21.24	--	22.04
Kansas:														
Cherokee	--	2	--	--	130	--	130	--	301	--	--	21.13	--	21.13
Crawford	--	2	--	--	115	--	115	--	285	--	--	12.24	--	12.24
Total or average	--	4	--	--	245	--	245	--	293	--	--	17.07	--	17.07

Table 12.—Number of mines, men working daily, days active, and output per man per day at bituminous coal and lignite mines in the United States, in 1972, by State and county—Continued

State and county	Number of mines			Average number of men working daily				Average number of days worked			Average tons per man per day			
	Underground	Strip	Auger	Underground	Strip	Auger	Total	Underground	Strip	Auger	Underground	Strip	Auger	Total
Kentucky:														
Eastern:														
Bell	15	27	15	332	514	35	881	176	182	163	11.99	28.51	59.01	23.50
Boyd	--	5	2	--	50	7	57	--	123	100	--	28.82	53.30	31.22
Breathitt	--	32	16	--	385	111	496	--	299	254	--	37.05	66.26	42.80
Carter	--	13	3	--	125	7	132	--	107	154	--	20.89	53.28	23.18
Clay	11	11	5	130	72	18	220	84	92	111	12.43	35.40	42.17	23.26
Clinton	--	1	--	--	31	--	31	--	122	--	--	16.52	--	16.52
Elliott	--	1	--	--	6	--	6	--	140	--	--	63.43	--	63.43
Floyd	107	20	14	1,583	267	51	1,901	173	125	120	9.20	37.17	82.93	13.61
Greenup	--	2	2	--	13	5	18	--	43	43	--	56.68	63.16	58.48
Harlan	67	36	31	2,403	150	77	2,630	237	166	136	12.95	53.45	67.08	15.55
Jackson	--	2	1	--	16	3	19	--	137	150	--	18.83	21.69	19.38
Johnson	12	17	5	166	200	91	457	152	247	96	8.26	32.86	38.22	25.98
Knott	48	18	13	1,009	65	40	1,114	195	131	166	13.96	51.46	33.67	16.08
Knox	5	24	7	42	227	20	289	120	113	107	4.37	24.76	55.30	23.63
Laurel	--	11	5	--	92	10	102	--	157	124	--	28.25	44.77	29.62
Lawrence	--	6	4	--	85	8	93	--	98	166	--	29.52	53.81	32.78
Lee	1	--	--	18	--	--	18	207	--	--	4.47	--	--	4.47
Leslie	12	18	9	390	111	32	533	226	90	137	15.05	36.32	41.55	18.25
Letcher	75	47	30	1,493	370	136	1,999	207	157	150	9.22	25.60	45.21	13.57
McCreary	5	3	1	288	60	3	351	255	165	113	12.48	10.67	36.06	12.36
Magoffin	2	7	3	11	58	8	77	101	241	55	9.07	29.84	27.72	28.29
Martin	12	14	4	662	105	16	783	237	122	159	11.15	52.64	49.20	14.78
Morgan	--	3	--	--	50	--	50	--	100	--	--	30.21	--	30.21
Owsley	--	1	1	--	5	3	8	--	208	139	--	25.80	31.06	27.27
Perry	37	34	18	957	318	144	1,419	194	177	142	13.59	27.91	46.77	19.25
Pike	251	65	42	5,436	359	342	6,137	199	141	127	13.57	48.01	46.44	16.27
Pulaski	2	3	--	36	39	--	75	66	250	--	7.30	45.81	--	38.25
Rockcastle	--	1	--	--	3	--	3	--	230	--	--	28.99	--	28.99
Wayne	--	3	1	--	10	2	12	--	49	30	--	22.00	35.00	23.42
Whitley	8	21	7	140	132	23	295	181	121	117	6.01	44.31	44.77	22.25
Total or average	670	446	239	15,096	3,918	1,192	20,206	203	166	143	12.37	33.99	51.59	17.71
Kentucky:														
Western:														
Butler	2	4	1	34	39	5	78	238	87	146	8.78	27.62	53.28	16.66
Christian	--	3	--	--	34	--	34	--	188	--	--	12.52	--	12.52
Daviess	--	2	--	--	112	--	112	--	265	--	--	34.08	--	34.08
Edmonson	--	1	--	--	20	--	20	--	260	--	--	30.79	--	30.79
Hancock	--	1	--	--	24	--	24	--	75	--	--	21.13	--	21.13
Henderson	1	--	--	45	--	--	45	172	--	--	11.26	--	--	11.26
Hopkins	10	21	2	1,433	426	19	1,878	239	226	62	16.08	53.63	44.01	24.37
McLean	--	3	--	--	117	--	117	--	182	--	--	51.78	--	51.78
Muhlenberg	6	16	2	982	1,649	20	2,651	248	269	53	20.94	47.21	43.98	37.91

Ohio	1	19	--	260	415	--	675	275	257	--	21.48	46.22	--	36.30
Union	6	--	--	1,585	--	--	1,585	232	--	--	13.45	--	--	13.45
Webster	1	1	--	175	16	--	191	279	250	--	26.65	29.40	--	26.86
Total or average	27	71	5	4,514	2,852	44	7,410	241	252	67	17.02	46.83	46.28	28.89
Total or average, Kentucky	697	517	244	19,610	6,770	1,236	27,616	212	202	140	13.59	40.73	51.50	21.26
Maryland:														
Allegany	1	17	3	4	95	6	105	167	204	91	9.95	26.02	16.75	25.25
Garrett	4	24	6	28	186	11	225	197	179	221	24.37	27.98	22.85	27.19
Total or average	5	41	9	32	281	17	330	193	187	175	22.82	27.26	21.73	26.55
Missouri:														
Barton	--	1	--	--	49	--	49	--	296	--	--	40.29	--	40.29
Bates	--	1	--	--	40	--	40	--	202	--	--	12.75	--	12.75
Boone	--	1	--	--	67	--	67	--	191	--	--	29.11	--	29.11
Callaway	--	1	--	--	10	--	10	--	148	--	--	15.00	--	15.00
Henry	--	2	--	--	212	--	212	--	281	--	--	31.89	--	31.89
Macon	--	1	--	--	150	--	150	--	281	--	--	23.94	--	23.94
Putnam	--	1	--	--	26	--	26	--	300	--	--	13.52	--	13.52
Randolph	--	1	--	--	29	--	29	--	300	--	--	51.19	--	51.19
Vernon	--	2	--	--	6	--	6	--	178	--	--	7.80	--	7.80
Total or average	--	11	--	--	589	--	589	--	265	--	--	29.14	--	29.14
Montana (bituminous):														
Big Horn	--	1	--	--	20	--	20	--	268	--	--	143.98	--	143.98
Musselshell	3	1	--	30	1	--	31	127	150	--	4.39	63.49	--	6.42
Rosebud	--	2	--	--	177	--	177	--	267	--	--	150.48	--	150.48
Total or average	3	4	--	30	198	--	228	127	266	--	4.39	149.59	--	139.80
Montana (lignite):														
Powder River	--	1	--	--	1	--	1	--	160	--	--	10.79	--	10.79
Richland	--	1	--	--	18	--	18	--	271	--	--	65.68	--	65.68
Total or average	--	2	--	--	19	--	19	--	265	--	--	63.94	--	63.94
Total or average, Montana	3	6	--	30	217	--	247	127	266	--	4.39	142.13	--	133.60
New Mexico:														
Colfax	1	1	--	227	8	--	235	270	74	--	16.53	28.16	--	16.64
McKinley	--	2	--	--	24	--	24	--	264	--	--	63.19	--	63.19
San Juan	--	1	--	--	321	--	321	--	255	--	--	83.22	--	83.22
Total or average	1	4	--	227	353	--	580	270	252	--	16.53	81.42	--	54.92

Table 12.—Number of mines, men working daily, days active, and output per man per day at bituminous coal and lignite mines in the United States, in 1972, by State and county—Continued

State and county	Number of mines			Average number of men working daily				Average number of days worked			Average tons per man per day			
	Under-ground	Strip	Auger	Under-ground	Strip	Auger	Total	Under-ground	Strip	Auger	Under-ground	Strip	Auger	Total
North Dakota (lignite):														
Adams	--	2	--	--	3	--	3	--	250	--	--	25.89	--	25.89
Bowman	--	1	--	--	14	--	14	--	220	--	--	53.82	--	53.82
Burke	--	2	--	--	40	--	40	--	246	--	--	49.48	--	49.48
Grant	--	1	--	--	2	--	2	--	95	--	--	16.73	--	16.73
McLean	--	1	--	--	5	--	5	--	280	--	--	11.57	--	11.57
Mercer	--	3	--	--	130	--	130	--	216	--	--	112.35	--	112.35
Oliver	--	1	--	--	49	--	49	--	258	--	--	179.51	--	179.51
Stark	--	1	--	--	12	--	12	--	224	--	--	43.38	--	43.38
Ward	--	1	--	--	27	--	27	--	233	--	--	62.42	--	62.42
Williams	--	1	--	--	2	--	2	--	75	--	--	34.67	--	34.67
Total or average	--	14	--	--	284	--	284	--	229	--	--	101.88	--	101.88
Ohio:														
Athens	--	1	--	--	2	--	2	--	111	--	--	6.31	--	6.31
Belmont	9	29	3	2,419	943	4	3,366	239	260	214	13.34	36.74	62.86	20.35
Carroll	--	6	2	--	69	5	74	--	288	35	--	21.21	34.24	21.33
Columbiana	3	24	4	14	165	14	193	180	259	284	16.24	20.15	34.51	20.85
Coshocton	2	7	3	119	204	17	340	295	298	260	13.33	31.62	41.79	25.64
Gallia	--	3	--	--	26	--	26	--	178	--	--	19.74	--	19.74
Guernsey	1	6	--	199	94	--	293	197	237	--	9.43	34.80	--	18.60
Harrison	5	19	3	1,491	358	6	1,855	230	250	256	10.24	46.97	42.50	17.94
Hocking	--	7	1	--	39	1	40	--	230	32	--	18.23	58.90	18.38
Holmes	--	6	--	--	56	--	56	--	247	--	--	54.13	--	54.13
Jackson	4	9	2	83	129	1	213	150	258	117	26.23	32.02	120.68	30.72
Jefferson	2	33	7	312	447	7	766	240	253	189	11.37	42.64	79.35	30.52
Lawrence	--	2	--	--	20	--	20	--	285	--	--	8.62	--	8.62
Mahoney	--	7	1	--	93	2	95	--	252	29	--	16.47	20.00	16.48
Meigs	1	--	--	66	--	--	66	70	--	--	6.27	--	--	6.27
Monroe	1	--	--	302	--	--	302	230	--	--	9.94	--	--	9.94
Morgan	--	2	--	--	56	--	56	--	239	--	--	51.85	--	51.85
Muskingum	1	7	1	16	440	1	457	216	166	164	12.46	73.00	58.90	69.60
Noble	--	4	--	--	56	--	56	--	288	--	--	59.00	--	59.00
Perry	4	12	2	425	96	2	523	297	210	101	17.20	36.82	42.53	19.94
Stark	--	11	3	--	80	3	83	--	268	250	--	16.23	13.10	16.13
Tuscarawas	2	30	3	106	355	31	492	83	272	148	7.89	19.19	58.19	17.73
Vinton	--	8	--	--	103	--	103	--	236	--	--	23.88	--	23.88
Washington	--	2	--	--	28	--	28	--	250	--	--	29.24	--	29.24
Wayne	--	1	--	--	4	--	4	--	263	--	--	30.08	--	30.08
Total or average	35	236	35	5,552	3,863	94	9,509	234	243	192	12.54	36.24	34.40	22.59

Oklahoma:														
Craig	--	2	--	--	92	--	92	--	293	--	--	30.72	--	30.72
Haskell	1	4	--	29	154	--	183	169	179	--	1.58	15.03	--	12.99
LeFlore	1	--	--	82	--	--	82	179	--	--	5.48	--	--	5.48
Muskogee	--	2	--	--	37	--	37	--	286	--	--	15.03	--	15.03
Novata	--	1	--	--	14	--	14	--	282	--	--	22.09	--	22.09
Pittsburg	--	1	--	--	16	--	16	--	325	--	--	24.21	--	24.21
Rogers	--	3	--	--	130	--	130	--	319	--	--	22.36	--	22.36
Total or average	2	13	--	111	443	--	554	177	261	--	4.50	21.96	--	19.43
Pennsylvania:														
Allegheny	7	10	--	1,328	100	--	1,428	241	262	--	11.81	29.48	--	13.14
Armstrong	19	59	11	1,458	398	38	1,894	230	177	92	15.63	36.05	27.16	19.24
Beaver	1	3	4	55	29	18	102	219	208	68	10.76	20.04	26.79	14.68
Bedford	1	--	--	3	--	--	3	67	--	--	5.24	--	--	5.24
Butler	4	31	2	204	233	3	440	216	209	237	12.83	20.04	75.81	17.07
Cambria	20	21	--	3,530	206	--	3,736	255	221	--	7.11	21.21	--	7.79
Centre	1	13	--	179	94	--	273	232	269	--	10.80	24.41	--	15.96
Clarion	--	62	--	--	480	--	480	--	294	--	--	30.32	--	30.32
Clearfield	10	97	6	403	871	15	1,289	230	267	178	11.80	19.65	20.65	17.44
Clinton	--	11	--	--	57	--	57	--	272	--	--	15.54	--	15.54
Elk	--	14	4	--	58	6	64	--	283	149	--	20.37	36.37	21.15
Fayette	3	50	1	582	163	6	751	253	207	108	5.30	32.42	27.01	10.42
Fulton	--	1	--	--	1	--	1	--	50	--	--	21.50	--	21.50
Greene	15	26	--	3,369	111	--	3,480	240	141	--	10.09	60.86	--	11.05
Indiana	29	49	8	2,893	376	18	3,287	237	225	147	9.87	19.21	25.00	10.94
Jefferson	5	39	5	70	216	11	297	81	236	188	8.47	24.80	30.56	23.42
Lawrence	--	16	4	--	178	14	192	--	150	52	--	19.61	20.36	19.63
Lycoming	--	3	--	--	16	--	16	--	299	--	--	27.31	--	27.31
Mercer	--	3	--	--	29	--	29	--	297	--	--	36.75	--	36.75
Somerset	20	64	8	618	530	22	1,170	225	245	89	9.94	17.79	43.61	13.95
Tioga	--	1	--	--	102	--	102	--	290	--	--	22.30	--	22.30
Venango	--	9	--	--	64	--	64	--	228	--	--	24.70	--	24.70
Washington	17	13	2	4,083	143	6	4,232	275	232	137	11.11	32.72	35.35	11.75
Westmoreland	7	27	--	669	155	--	824	246	167	--	11.31	19.99	--	12.49
Total or average	159	622	55	19,444	4,610	157	24,211	248	236	113	10.19	24.18	30.53	12.82
Tennessee:														
Anderson	25	22	5	335	173	25	533	183	206	223	21.97	36.99	21.50	27.16
Bledsoe	--	2	--	--	13	--	13	--	219	--	--	28.40	--	28.40
Campbell	20	13	2	272	167	8	447	265	235	231	12.28	23.79	74.59	17.27
Clairborne	5	10	--	431	111	--	542	235	265	--	14.53	30.95	--	18.22
Cumberland	2	3	--	4	10	--	14	150	59	--	16.49	27.99	--	21.90
Fentress	2	7	--	8	80	--	88	197	114	--	16.50	42.49	--	38.75
Grundy	--	6	--	--	52	--	52	--	124	--	--	28.10	--	28.10
Hamilton	2	1	--	9	7	--	16	197	247	--	16.50	28.00	--	21.90
Marion	17	3	--	210	11	--	221	185	107	--	16.60	28.00	--	16.93
Morgan	6	8	1	25	49	2	76	216	220	100	16.50	37.97	58.94	31.16
Overton	--	1	--	--	4	--	4	--	27	--	--	28.04	--	28.04
Putnam	1	--	--	32	--	--	32	200	--	--	12.85	--	--	12.85
Rhea	2	--	--	4	--	--	4	227	--	--	16.50	--	--	16.50
Roane	--	1	--	--	5	--	5	--	250	--	--	57.60	--	57.60
Scott	18	14	1	249	120	4	373	256	164	100	15.52	22.38	35.50	17.22

Table 12.—Number of mines, men working daily, days active, and output per man per day at bituminous coal and lignite mines in the United States, in 1972, by State and county—Continued

State and county	Number of mines			Average number of men working daily				Average number of days worked			Average tons per man per day			
	Underground	Strip	Auger	Underground	Strip	Auger	Total	Underground	Strip	Auger	Underground	Strip	Auger	Total
Tennessee—Continued														
Sequatchie	5	1	--	65	13	--	78	258	254	--	8.93	38.91	--	14.00
Van Buren	1	2	--	8	23	--	31	250	256	--	15.00	26.25	--	23.40
White	2	--	--	19	--	--	19	200	--	--	25.00	--	--	25.00
Total or average	108	94	9	1,671	838	39	2,548	225	199	205	15.58	30.61	35.19	20.41
Texas (lignite)	--	3	--	--	244	--	244	--	300	--	--	55.22	--	55.22
Utah:														
Carbon	11	1	--	1,094	5	--	1,099	217	236	--	12.69	27.25	--	12.76
Emery	8	--	--	460	--	--	460	244	--	--	13.98	--	--	13.98
Sevier	1	--	--	20	--	--	20	250	--	--	36.60	--	--	36.60
Summit	1	--	--	3	--	--	3	115	--	--	15.99	--	--	15.99
Total or average	21	1	--	1,577	5	--	1,582	225	236	--	13.44	27.25	--	13.49
Virginia:														
Buchanan	215	48	47	5,445	314	84	5,843	210	209	188	9.62	20.66	53.46	10.78
Dickinson	34	37	16	1,780	232	41	2,053	234	209	160	10.71	31.80	35.40	13.22
Lee	20	17	10	263	38	62	363	207	211	99	12.55	27.12	21.74	15.09
Russell	4	12	10	755	171	10	936	238	135	35	10.11	33.63	54.09	13.23
Scott	2	--	--	12	--	--	12	198	--	--	5.80	--	--	5.80
Tazewell	13	11	5	695	87	5	787	239	154	97	7.91	33.88	41.06	9.94
Wise	39	119	34	1,797	533	74	2,404	240	186	172	10.91	36.10	59.00	16.64
Total or average	327	244	122	10,747	1,375	276	12,398	223	188	159	10.02	30.75	47.85	12.62
Washington:														
King	1	--	--	17	--	--	17	205	--	--	8.18	--	--	8.18
Lewis	--	2	--	--	196	--	196	--	254	--	--	52.34	--	52.34
Total or average	1	2	--	17	196	--	213	205	254	--	8.18	52.34	--	49.44
West Virginia:														
Barbour	12	17	2	571	474	64	1,109	216	166	47	10.59	30.86	29.63	18.65
Boone	40	21	14	3,119	450	168	3,737	220	112	54	12.90	33.26	30.85	14.30
Braxton	1	--	--	5	--	--	5	97	--	--	3.16	--	--	3.16
Brooke	2	6	1	220	55	4	279	243	160	16	12.76	23.60	163.23	14.45
Clay	1	1	--	23	9	--	32	203	40	--	5.30	10.38	--	5.66
Fayette	24	13	6	1,503	150	27	1,680	228	124	44	7.86	31.50	39.39	9.66
Gilmer	--	1	--	--	12	--	12	--	180	--	--	22.89	--	22.89
Grant	3	8	--	174	495	--	669	223	194	--	12.43	12.90	--	12.55
Greenbrier	4	12	--	87	148	--	235	188	123	--	6.52	24.80	--	16.15
Harrison	10	18	3	1,425	266	21	1,712	181	147	71	12.99	32.40	63.67	17.86

Kanawha	41	23	25	2,820	500	340	3,660	220	149	88	11.22	36.09	34.26	14.73
Lewis	--	7	1	--	63	7	70	--	122	169	--	34.57	50.72	36.73
Logan	55	12	14	3,770	235	210	4,215	211	91	93	10.62	36.39	27.64	11.68
McDowell	109	17	4	6,034	223	26	6,283	221	156	77	10.00	23.29	26.14	10.36
Marion	7	3	--	2,259	31	--	2,290	237	62	--	13.33	46.34	--	13.45
Marshall	4	--	--	1,942	--	--	1,942	236	--	--	13.94	--	--	13.94
Mason	1	--	--	112	--	--	112	155	--	--	10.43	--	--	10.43
Mercer	4	3	2	465	18	22	505	242	160	56	9.09	19.84	27.20	9.54
Mineral	1	5	--	30	47	--	77	221	232	--	16.10	21.20	--	19.29
Mingo	32	11	10	1,383	329	113	1,825	199	150	97	9.46	19.54	39.88	11.67
Monongalia	17	12	--	2,986	90	--	3,076	215	169	--	18.56	40.21	--	19.06
Nicholas	40	18	5	2,033	320	69	2,422	230	144	87	9.89	28.68	12.40	11.59
Ohio	2	--	--	833	--	--	833	236	--	--	11.21	—	—	11.21
Preston	12	26	--	250	217	--	467	196	175	--	14.23	21.82	--	17.55
Raleigh	30	13	6	3,063	403	62	3,528	233	178	151	7.71	15.53	19.72	8.56
Randolph	9	11	--	222	198	--	420	114	177	--	9.80	19.21	--	15.26
Taylor	--	5	--	--	38	--	38	--	80	--	--	91.94	--	91.94
Tucker	--	2	--	--	18	--	18	--	156	--	--	50.98	--	50.98
Upshur	5	10	--	130	160	--	290	212	118	--	10.34	33.76	--	19.83
Wayne	2	--	--	149	--	--	149	205	--	--	12.35	--	--	12.35
Webster	9	3	1	145	55	3	203	84	30	48	7.25	10.43	17.58	8.18
Wyoming	71	10	5	5,115	187	28	5,330	221	198	65	9.20	17.67	25.75	9.49
Total or average	548	288	99	41,168	4,891	1,164	47,223	220	146	83	11.23	26.69	30.69	12.55
Wyoming:														
Campbell	--	2	--	--	30	--	30	--	281	--	--	77.69	--	77.69
Carbon	1	4	--	78	256	--	334	260	251	--	16.53	59.92	--	49.50
Converse	--	2	--	--	72	--	72	--	258	--	--	141.23	--	141.23
Hot Springs	2	--	--	5	--	--	5	180	--	--	6.31	--	--	6.31
Lincoln	--	2	--	--	NA	--	NA	--	NA	--	--	NA	--	NA
Sheridan	--	2	--	--	80	--	80	--	216	--	--	56.36	--	56.36
Sweetwater	2	1	--	70	60	--	130	173	192	--	8.30	25.06	--	16.47
Total or average	5	13	--	153	721	--	874	218	245	--	13.26	59.31	--	52.01
Grand total or average United States	1,996	2,309	574	112,252	34,027	2,986	149,265	227	225	121	11.91	35.95	43.00	17.74

NA Not available.

Table 13.—Underground mine data for bituminous coal in 1972, by State

(Thousand short tons)

State	Number of mines	Production	Cut by hand and 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	Number of mines using power drills	Face or coal drills: Handheld and post mounted: Number	Face or coal drills: Handheld and post mounted: Quantity	Face or coal drills: Mobile: Number	Face or coal drills: Mobile: Quantity	Roof or rock drills: Roof bolting: Rotary	Roof or rock drills: Roof bolting: Percussion	Roof or rock drills: Other uses: Rotary	Roof or rock drills: Other uses: Percussion
Alabama	24	7,588	27	6,671	64	104	891	--	17	25	1,152	49	5,523	37	7	3	5
Arkansas	1	8	--	8	2	4	--	--	1	2	8	--	--	--	--	--	--
Colorado	27	3,070	1	162	21	8	2,598	308	18	15	77	10	233	40	2	--	--
Illinois	26	31,721	--	7,295	30	243	24,411	15	22	--	--	30	7,295	147	--	7	2
Indiana	4	1,446	--	373	5	75	1,073	--	4	--	--	5	373	15	--	1	2
Iowa	2	352	--	352	3	117	--	--	2	--	--	2	352	--	--	--	--
Kentucky	697	56,494	2,489	41,223	649	64	12,781	--	549	547	13,662	237	29,460	317	57	16	2
Maryland	5	141	--	13	5	3	128	--	4	3	7	--	--	3	2	--	--
Montana	3	17	--	17	4	4	--	--	3	3	9	1	7	--	--	--	--
New Mexico	1	1,014	--	--	--	--	1,014	--	1	--	--	--	--	7	--	--	--
Ohio	35	16,269	--	5,702	58	98	10,568	--	30	7	675	51	5,023	208	--	--	--
Oklahoma	2	88	--	--	--	--	88	--	1	--	--	--	--	5	--	--	--
Pennsylvania	159	49,133	7	3,775	70	54	42,997	2,354	105	54	2,221	21	1,822	318	231	15	20
Tennessee	108	5,866	433	4,122	119	35	1,311	--	101	175	4,448	2	75	17	--	--	--
Utah	21	4,770	--	442	10	44	3,604	723	17	4	58	6	385	16	23	--	3
Virginia	327	23,993	777	10,730	293	37	11,269	1,217	291	306	6,782	82	8,138	208	77	7	--
Washington	1	29	29	--	--	--	--	--	1	4	29	--	--	--	--	--	--
West Virginia	548	101,662	434	32,776	551	59	65,306	3,146	427	330	11,335	316	22,750	775	183	14	2
Wyoming	5	442	--	106	6	18	335	--	5	4	99	3	103	5	6	--	--
Total or average [1]	1,996	304,103	4,198	113,766	1,890	60	178,375	7,763	1,599	1,479	40,562	815	81,538	2,118	588	63	36

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

Table 14.—Haulage units in use in bituminous coal and lignite underground mines in 1972, by State

State	Locomotives			Tractors rubber-tired	Trailers rubber-tired	Rail mine cars	Shuttle cars		Shuttle buggies	Gathering and haulage conveyors	
	Trolly	Battery	All other				Cable reel	Battery		Units	Miles
Alabama	115	--	--	39	77	1,971	161	--	--	82	29.9
Arkansas	--	--	--	--	--	5	--	--	--	4	.4
Colorado	47	5	--	9	--	1,099	105	3	1	46	12.8
Illinois	106	20	--	93	111	144	413	10	--	286	189.0
Indiana	1	--	--	--	--	37	17	--	--	34	11.6
Iowa	5	--	--	--	--	18	5	--	--	--	--
Kentucky	206	93	--	604	751	3,539	791	196	67	531	223.1
Maryland	--	--	--	3	3	--	--	3	3	3	.5
Montana (bituminous)	3	--	--	--	--	38	2	--	--	--	--
New Mexico	--	--	--	--	--	--	14	--	--	12	6.8
Ohio	126	9	--	89	52	2,472	256	31	3	171	64.9
Oklahoma	--	--	--	--	--	--	12	--	--	8	2.7
Pennsylvania	1,102	38	--	287	587	12,376	1,072	19	8	634	241.4
Tennessee	49	24	--	59	124	461	83	1	30	39	14.0
Utah	58	3	--	18	45	1,586	106	9	--	71	17.2
Virginia	161	51	--	378	360	2,260	521	101	2	421	170.3
Washington	2	--	--	--	--	20	--	--	--	--	--
West Virginia	1,126	62	--	355	407	25,128	2,226	197	142	1,426	599.2
Wyoming	--	--	--	3	5	20	13	--	--	8	2.7
Total	3,107	305	--	1,937	2,522	51,174	5,797	570	256	3,776	1,586.5

Table 15.—Rail mine cars used and haulage at bituminous coal underground mines, in 1972, by State

State	Capacity							Production, by size of mine car reported (thousand short tons)						
	1 ton	2 tons	3 tons	4–5 tons	6–9 tons	10 tons and over	Total [1]	1 ton	2 tons	3 tons	4–5 tons	6–9 tons	10 tons and over	Total [1]
Alabama	--	16	80	586	911	378	1,971	--	12	175	737	1,789	886	3,599
Arkansas	--	--	--	5	--	--	5	--	--	--	8	--	--	8
Colorado	20	728	--	171	80	100	1,099	6	282	--	243	148	380	1,059
Illinois	--	32	--	60	--	52	144	--	64	--	47	--	4,693	4,804
Indiana	--	--	16	21	--	--	37	--	--	104	85	--	--	189
Iowa	--	--	18	--	--	--	18	--	--	239	--	--	--	239
Kentucky	21	53	711	788	1,217	749	3,539	26	226	1,274	4,832	2,405	5,945	14,709
Montana (bituminous)	--	12	--	26	--	--	38	--	5	--	12	--	--	17
Ohio	--	--	--	572	1,045	855	2,472	--	--	--	1,806	2,580	3,663	8,049
Pennsylvania	110	910	598	65	4,819	5,874	12,376	31	598	2,975	675	10,275	17,958	32,512
Tennessee	10	225	222	4	--	--	461	15	768	1,088	5	--	--	1,876
Utah	--	21	--	1,286	279	--	1,586	--	6	--	2,075	1,156	--	3,237
Virginia	--	44	281	1,225	270	440	2,260	--	242	4,714	5,888	2,338	2,770	15,952
Washington	--	--	--	20	--	--	20	--	--	--	29	--	--	29
West Virginia	4	357	2,154	7,766	3,364	11,473	25,118	9	453	3,725	13,880	10,426	47,672	76,166
Wyoming	--	20	--	--	--	--	20	--	3	--	--	--	--	3
Total	165	2,418	4,080	12,595	11,985	19,921	51,164	87	2,659	14,294	30,322	31,117	83,967	162,448

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

Table 16.—Number and production of underground bituminous coal mines using gathering and haulage conveyors, and number and length of units in use, by State[1]

State	Number of mines		Production (thousand short tons)		Number of units in use		Average length (feet)		Total length (miles)	
	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972
Alabama	7	8	3,706	6,016	114	82	1,968	1,925	42.5	29.9
Arkansas	1	1	41	8	4	4	500	500	.4	.4
Colorado	9	13	3,212	3,070	37	46	1,250	1,467	8.8	12.8
Illinois	24	22	29,234	31,593	279	286	2,700	2,723	142.7	189.0
Indiana	1	2	713	1,256	14	34	r 2,000	1,794	r 5.3	11.6
Kentucky	65	116	28,653	36,872	501	531	1,861	2,218	176.6	223.1
Maryland	1	1	68	28	3	3	800	800	.5	.5
New Mexico	1	1	977	1,014	10	12	2,600	3,000	4.9	6.8
Ohio	19	27	12,083	16,155	134	171	2,434	2,005	61.8	64.9
Oklahoma	3	2	193	88	10	8	1,800	1,750	3.4	2.7
Pennsylvania	93	96	28,618	32,201	619	634	1,921	2,010	225.2	241.4
Tennessee	10	10	2,014	1,989	30	39	2,597	1,892	14.8	14.0
Utah	14	14	4,207	4,248	61	71	1,336	1,276	15.4	17.2
Virginia	43	71	13,665	17,111	292	421	2,181	2,136	120.6	170.3
West Virginia	247	285	106,894	87,667	1,326	1,426	2,240	2,219	562.5	599.2
Wyoming	2	1	133	3	3	8	767	1,813	.4	2.7
Total or average	540	670	234,411	239,319	3,437	3,776	r 2,129	2,160	r 1,385.8	1,586.5

r Revised.
[1] Includes all mines using belt conveyors, 500 feet long or more for transporting coal underground. Excludes mainslope conveyors.

Table 17.—Number and production of bituminous coal and lignite strip mines and units of stripping and loading equipment in 1972, 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				By type of machine		Total	Number of carryall scrapers	Number of bulldozers	Front-end loaders	Wheel excavators	Power brooms	Motor graders	Coal drills
			Electric	Diesel electric	Diesel	Gasoline	Less than 6	6 to 15	16 to 50	More than 50	Power shovels	Dragline excavators								
Alabama	101	13,177	16	8	124	2	92	34	22	2	109	41	150	6	181	145	--	5	17	10
Alaska	1	668	--	--	--	--	--	--	--	--	--	--	--	2	5	4	--	--	1	--
Arizona	1	2,954	4	1	--	--	--	1	3	1	2	3	5	--	5	2	--	--	2	2
Arkansas	7	420	1	3	5	--	2	6	1	--	2	7	9	--	13	7	--	2	1	--
Colorado	8	2,452	6	--	3	--	3	5	1	--	5	4	9	--	18	9	--	--	4	5
Illinois	33	33,802	68	10	24	--	26	38	19	19	58	44	102	34	169	55	9	--	31	20
Indiana	36	24,503	51	3	41	2	45	28	12	12	56	41	97	20	127	38	--	1	19	5
Iowa	9	499	--	2	21	1	20	4	--	--	11	13	24	2	19	8	--	--	4	9
Kansas	4	1,227	7	--	2	--	4	3	1	1	4	5	9	2	18	5	--	--	3	--
Kentucky:																				
Eastern	[1] 446	22,132	1	2	[1] 512	[1] 39	[1] 520	[1] 33	1	--	548	6	554	[1] 18	[1] 508	[1] 346	--	[1] 17	[1] 72	[1] 22
Western	[1] 71	33,645	[1] 56	5	[1] 92	4	88	41	28	--	120	37	157	8	[1] 228	[1] 105	--	1	[1] 29	2
Total [2]	517	55,776	57	7	604	43	608	74	29	--	668	43	711	26	736	451	--	18	101	24
Maryland	41	1,435	--	--	64	1	56	9	--	--	49	16	65	--	60	34	--	--	5	3
Missouri	11	4,551	16	2	8	1	7	10	8	2	14	13	27	13	32	12	--	--	7	--
Montana:																				
Bituminous	4	7,882	7	--	1	--	1	3	4	--	5	3	8	4	9	5	--	--	4	3
Lignite	2	322	1	--	1	--	2	--	--	--	1	1	2	1	2	3	--	1	1	1
Total	6	8,204	8	--	2	--	3	3	4	--	6	4	10	5	11	8	--	1	5	4
New Mexico	4	7,235	--	--	1	--	1	--	--	--	1	--	1	--	--	1	--	--	1	--
North Dakota (lignite)	14	6,632	20	1	10	5	22	6	8	--	22	14	36	15	31	16	--	2	13	8
Ohio	[1] 236	34,077	[1] 43	[1] 23	[1] 354	9	[1] 310	[1] 102	[1] 13	4	308	121	429	[1] 69	[1] 571	[1] 291	--	[1] 17	84	9
Oklahoma	13	2,536	8	2	9	--	6	6	7	--	12	7	19	10	26	25	--	3	4	1
Pennsylvania	622	26,264	19	43	670	6	555	176	6	1	437	301	738	46	862	473	--	1	38	9
Tennessee	94	5,113	--	7	125	3	110	25	--	--	130	5	135	16	162	141	--	7	--	11
Texas (lignite)	3	4,045	8	1	2	--	2	3	4	2	6	5	11	2	11	3	--	--	8	--
Utah	1	32	--	--	1	--	1	--	--	--	1	--	1	1	1	--	--	--	--	--
Virginia	[1] 244	7,935	--	1	264	15	262	18	--	--	258	22	280	28	[1] 258	[1] 148	--	9	[1] 28	17
Washington	2	2,606	4	--	2	--	2	2	2	--	4	2	6	9	15	4	--	--	2	4
West Virginia	288	19,101	2	11	311	13	269	66	2	--	304	33	337	20	513	310	--	23	78	29
Wyoming	13	10,487	16	--	10	1	12	8	4	3	17	10	27	34	47	21	--	1	13	11
Total [2]	2,309	275,730	354	125	2,657	102	2,418	627	146	47	2,484	754	3,238	360	3,891	2,211	9	90	469	181

[1] Strip and auger combined for units of stripping and loading equipment in the States of Kentucky, Ohio, and Virginia.
[2] Data may not add to totals shown because of independent rounding.

Table 18.—Bituminous coal and lignite mechanically loaded underground in the United States, by type of loading equipment

(Thousand short tons)

Type of loading equipment	1971	1972
Mobile loading machines:		
Direct into mine cars or onto conveyors	10,857	15,483
Into shuttle cars	100,210	99,508
Continuous-mining machines:		
Onto conveyors	10,857	11,673
Into shuttle or mine cars	116,079	132,792
Onto bottom	26,007	33,911
Longwall machines	6,552	7,763
Total mechanically loaded [1]	[2] 270,896	301,129

[1] Data may not add to totals shown because of independent rounding.
[2] Total includes 334,000 tons loaded by duckbills, scraper loaders, and handloaded conveyors. Not canvassed in 1972.

Table 19.—Comparative changes in underground mechanical loading of bituminous coal by principal types of loading devices, by State

(Thousand short tons)

State	Mobile loading machines		Continuous-mining machines		Longwall machines		Total mechanically loaded [1,2]		Total production at mines using mechanical loading devices	
	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972
Alabama	6,125	6,636	591	891	--	--	6,716	7,527	6,716	7,527
Colorado	257	147	2,789	2,598	255	308	3,315	3,053	3,315	3,053
Illinois	9,122	7,295	20,324	24,411	--	15	29,446	31,721	29,446	31,721
Indiana	658	373	1,107	1,073	--	--	1,765	1,446	1,765	1,446
Iowa	418	352	--	--	--	--	418	352	418	352
Kentucky	39,484	42,095	11,074	12,781	--	--	50,585	54,877	50,610	54,877
Maryland	46	7	111	128	--	--	157	135	157	135
Montana	11	7	--	--	--	--	20	7	20	7
New Mexico	--	--	977	1,014	--	--	977	1,014	977	1,014
Ohio	5,372	5,692	7,475	10,568	--	--	12,847	16,260	12,847	16,260
Oklahoma	--	--	193	88	--	--	193	88	193	88
Pennsylvania	4,573	3,647	37,570	42,997	1,925	2,354	44,119	48,998	44,126	48,998
Tennessee	2,729	4,376	656	1,311	--	--	3,396	5,687	3,396	5,687
Utah	369	442	3,494	3,604	735	723	4,608	4,770	4,608	4,770
Virginia	10,753	11,480	9,235	11,269	1,139	1,217	21,167	23,967	21,167	23,967
Washington	26	29	--	--	--	--	30	29	30	29
West Virginia	31,033	32,309	57,299	65,306	2,499	3,146	90,996	100,762	91,018	100,762
Wyoming	92	103	45	335	--	--	141	438	141	438
Total [2]	111,068	114,990	152,940	178,375	6,553	7,763	270,896	301,129	270,951	301,129

[1] Totals for 1971 include duckbills, scraper loaders, and hand-loaded conveyors. Not canvassed for 1972.
[2] Data may not add to totals shown because of independent rounding.

Table 20.—Number of bituminous and lignite underground mines using mechanical loading devices and number of units in use, by State

State	Number of mines								Number of loading devices					
	Using mobile loading machines		Using continuous-mining machines only		Using more than one type of loading device		Total [1]		Mobile loading machines		Continuous-mining machines		Longwall machines	
	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972
Alabama	8	9	--	--	3	4	11	13	77	68	8	7	--	--
Colorado	8	7	13	12	4	4	28	23	40	18	38	39	1	1
Illinois	10	10	12	12	5	4	27	26	53	42	119	139	--	1
Indiana	2	2	1	1	1	1	4	4	12	6	7	7	--	--
Iowa	2	2	--	--	--	--	2	2	3	5	--	--	--	--
Kentucky	379	402	50	55	13	11	444	468	617	657	129	142	--	--
Maryland	3	1	2	2	--	--	5	3	7	2	2	2	--	--
Montana	2	1	--	--	--	--	4	1	4	2	--	--	--	--
New Mexico	--	--	1	1	--	--	1	1	6	--	6	6	--	--
Ohio	13	13	13	15	4	5	30	33	66	68	100	112	--	--
Oklahoma	--	--	3	2	--	--	3	2	--	--	8	6	--	--
Pennsylvania	31	19	95	90	14	18	150	127	120	68	501	498	9	12
Tennessee	45	82	--	2	1	--	48	84	63	115	5	5	--	--
Utah	5	6	10	12	3	3	18	21	17	17	36	37	3	3
Virginia	168	111	46	38	75	167	291	316	266	314	139	161	7	8
Washington	--	1	--	--	1	--	1	1	1	1	--	--	--	--
West Virginia	189	206	135	134	104	88	432	428	710	572	681	685	14	15
Wyoming	2	3	1	1	--	--	4	4	3	4	2	3	--	--
Total [1]	867	875	382	377	228	305	1,503	1,557	2,065	1,959	1,781	1,849	34	40

[1] Totals for 1971 include duckbills, scraper loaders, and hand-loaded conveyors. Not canvassed for 1972.

Table 21.—Production at underground bituminous coal mines, by State and method of loading

(Thousand short tons)

State	Hand-loaded		Mechanically loaded		Total underground production	
	1971	1972	1971	1972	1971	1972
Alabama	35	61	6,716	7,527	6,751	7,588
Arkansas	41	8	--	--	41	8
Colorado	14	17	3,315	3,053	3,329	3,070
Illinois	--	--	29,446	31,721	29,446	31,721
Indiana	--	--	1,765	1,446	1,765	1,446
Iowa	--	--	418	352	418	352
Kentucky	2,631	1,617	50,585	54,877	53,216	56,494
Maryland	19	7	157	135	176	141
Montana	--	9	20	7	20	17
New Mexico	--	--	977	1,014	977	1,014
Ohio	15	10	12,847	16,260	12,862	16,269
Oklahoma	--	--	193	88	193	88
Pennsylvania	170	135	44,119	48,998	44,289	49,133
Tennessee	147	179	3,396	5,687	3,543	5,866
Utah	12	--	4,608	4,770	4,620	4,770
Virginia	464	27	21,167	23,967	21,631	23,993
Washington	2	--	30	29	32	29
West Virginia	1,441	901	90,996	100,762	92,437	101,662
Wyoming	--	3	141	438	141	442
Total [1]	4,992	2,974	270,896	301,129	275,888	304,103

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

Table 22.—Mechanical cleaning at bituminous coal and lignite mines in 1972, by State

(Thousand short tons)

State	Total production	Mechanical cleaning			
		Number of cleaning plants	Raw coal	Cleaned coal	Refuse
Alabama	20,814	20	17,536	11,690	5,847
Alaska	668	1	90	60	30
Colorado	5,522	3	1,461	1,240	221
Illinois	65,523	38	64,182	48,837	15,346
Indiana	25,949	11	25,434	19,577	5,857
Kentucky	121,187	50	50,530	38,608	11,922
Ohio	50,967	21	19,784	14,163	5,622
Oklahoma	2,624	6	772	573	199
Pennsylvania	75,939	71	61,601	45,612	15,989
Tennessee	11,260	2	1,554	1,253	301
Utah	4,802	7	3,844	3,333	511
Virginia	34,028	31	25,942	17,763	8,179
Washington	2,634	2	3,794	2,625	1,168
West Virginia	123,743	136	116,530	83,325	33,205
Other States [1]	49,725	9	5,625	4,171	1,454
Total [2]	595,386	408	398,678	292,829	105,850

[1] Includes Arizona, Arkansas, Iowa, Kansas, Maryland, Missouri, Montana (bituminous and lignite), New Mexico, North Dakota (lignite), Texas (lignite), and Wyoming.
[2] Data may not add to totals shown because of independent rounding.

Table 23.—Mechanical cleaning of bituminous coal and lignite, by type of equipment

(Thousand short tons)

Type of equipment	1971	1972
Wet methods:		
Jigs	115,407	127,591
Concentrating tables	35,656	40,257
Classifiers	2,071	2,980
Launders	4,896	5,467
Dense medium processes:		
Magnetite	70,262	74,667
Sand	17,802	15,273
Calcium chloride	1,702	2,081
Total [1]	89,764	92,021
Flotation	9,098	12,802
Total, wet methods [1]	256,892	281,119
Pneumatic methods	14,506	11,710
Grand total [1]	271,401	292,829

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

Table 24.—Mechanical cleaning at bituminous coal and lignite mines by State, and type of mining

(Thousand short tons)

State	Underground mines		Strip mines		Auger mines		Total, all mines [1]	
	Total production	Cleaned	Total production	Cleaned	Total production	Cleaned	Total production	Cleaned
Alabama	7,588	7,509	13,177	4,180	49	--	20,814	11,690
Alaska	--	--	668	60	--	--	668	60
Colorado	3,070	1,240	2,452	--	--	--	5,522	1,240
Illinois	31,721	19,161	33,802	29,675	--	--	65,523	48,837
Indiana	1,446	391	24,503	19,186	--	--	25,949	19,577
Kentucky	56,494	24,148	55,776	14,425	8,917	35	121,187	38,608
Ohio	16,269	10,766	34,077	3,359	621	38	50,967	14,163
Oklahoma	88	88	2,536	485	--	--	2,624	573
Pennsylvania	49,133	39,312	26,264	6,268	542	32	75,939	45,612
Tennessee	5,866	1,253	5,113	--	281	--	11,260	1,253
Utah	4,770	3,333	32	--	--	--	4,802	3,333
Virginia	23,993	17,763	7,935	--	2,100	--	34,028	17,763
Washington	29	29	2,606	2,597	--	--	2,634	2,625
West Virginia	101,662	79,038	19,101	3,732	2,979	555	123,743	83,325
Other States [2]	1,973	956	47,687	3,216	65	--	49,725	4,171
Total [1]	304,103	204,986	275,730	87,183	15,554	660	595,386	292,829

[1] Data may not add to totals shown because of independent rounding.
[2] Includes Arizona, Arkansas, Iowa, Kansas, Maryland, Missouri, Montana (bituminous and lignite), New Mexico, North Dakota (lignite), Texas, (lignite), and Wyoming.

Table 25.—Mechanical crushing of bituminous coal and lignite at mines, by State

State	Number of plants crushing coal		Coal crushed (thousand short tons)	
	1971	1972	1971	1972
Alabama	39	22	12,801	13,879
Alaska	2	1	406	526
Arizona	1	1	1,146	2,954
Arkansas	5	5	237	383
Colorado	25	17	3,475	7,942
Illinois	37	43	36,150	56,171
Indiana	22	23	15,361	25,259
Iowa	9	9	570	696
Kansas	3	2	1,146	1,219
Kentucky	153	148	56,993	74,139
Maryland	14	9	783	523
Missouri	7	7	3,978	2,958
Montana:				
Bituminous	3	3	6,661	7,109
Lignite	2	1	325	320
Total	5	4	6,986	7,429
New Mexico	3	4	8,175	8,007
North Dakota (lignite)	11	9	5,119	4,710
Ohio	92	95	28,036	32,276
Oklahoma	7	9	2,019	791
Pennsylvania	188	149	48,532	57,512
Tennessee	19	25	2,780	3,456
Utah	15	12	5,189	4,130
Virginia	52	58	15,707	20,584
Washington	2	3	39	2,634
West Virginia	210	257	59,565	106,334
Wyoming	11	13	7,998	10,902
Total	932	925	323,191	445,414

Table 26.—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)	
	1971	1972	1971	1972
Fluidized-bed	77	79	32,564	34,118
Multilouver	20	17	6,337	2,861
Rotary	4	40	835	6,924
Screen	10	14	1,176	2,776
Suspension or flash	32	31	5,432	6,098
Vertical tray and cascade	16	3	1,761	459
Total [1]	159	184	48,105	53,235

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

Table 27.—Comparison of thermal drying of bituminous coal and lignite with mechanical cleaning at mines, by State

(Thousand short tons)

State	Number of cleaning plants				Production mechanically cleaned		Thermally dried	
	Total		With thermal drying					
	1971	1972	1971	1972	1971	1972	1971	1972
Alabama	22	20	--	1	9,142	11,690	--	1,254
Colorado	3	3	1	1	1,780	1,240	600	324
Illinois	40	38	11	9	45,336	48,837	5,254	7,163
Indiana	11	11	2	1	16,547	19,577	426	1,337
Kentucky	50	50	8	15	36,114	38,608	2,532	4,233
North Dakota (lignite)	--	--	2	2	--	--	155	164
Ohio	20	21	5	4	10,938	14,163	1,898	1,275
Pennsylvania	68	71	9	13	42,632	45,612	6,056	5,569
Utah	7	7	2	2	4,156	3,333	838	720
Virginia	30	31	10	10	16,171	17,763	6,984	4,496
West Virginia	142	136	53	54	81,576	83,325	23,362	26,700
Other States	18	20	--	--	7,011	8,683	--	--
Total [1]	411	408	103	112	271,401	292,829	48,105	53,235

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

Table 28.—Thermal drying of bituminous coal and lignite at mines, by State

(Thousand short tons)

State	Number of thermal drying units		Grand total production		Thermally dried	
	1971	1972	1971	1972	1971	1972
Alabama	--	3	17,945	20,814	--	1,254
Colorado	1	1	5,337	5,522	600	324
Illinois	18	24	58,402	65,523	5,254	7,163
Indiana	3	7	21,396	25,949	426	1,337
Kentucky	10	20	119,389	121,187	2,532	4,233
North Dakota (lignite)	2	2	6,075	6,632	155	164
Ohio	10	8	51,431	50,967	1,898	1,275
Pennsylvania	11	21	72,835	75,939	6,056	5,569
Utah	2	2	4,626	4,802	838	720
Virginia	23	20	30,628	34,028	6,984	4,496
West Virginia	79	76	118,258	123,743	23,362	26,700
Other States	--	--	45,869	60,280	--	--
Total [1]	159	184	552,192	595,386	48,105	53,235

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

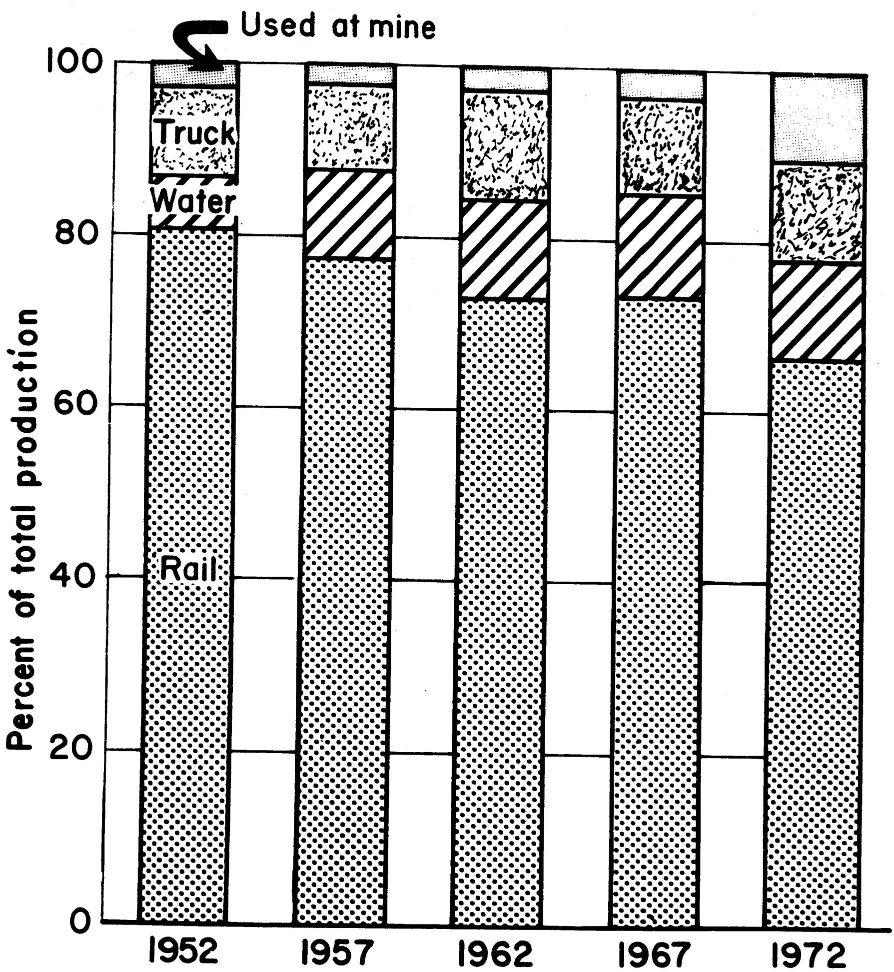

Figure 4.—Percentage of total production of bituminous coal and lignite by method of shipment from mines and percentage used at mines.

Table 29.—Bituminous coal and lignite loaded for shipment by railroads and waterways in the United States, in 1972, as reported by mine operators

(Thousand short tons)

Route	State	By State	Total for route
RAILROAD			
Alaska	Alaska	566	556
Atchison, Topeka & Santa Fe	Illinois	60	1,487
	New Mexico	1,427	
Baltimore & Ohio	Illinois	343	29,720
	Ohio	9,199	
	Pennsylvania	3,455	
	West Virginia	16,721	
Bevier & Southern	Missouri	1,010	1,010
Bessemer & Lake Erie	Pennsylvania	1,717	1,717
Burlington Northern	Illinois	9,540	22,132
	Iowa	284	
	Missouri	53	
	Montana (Bit. and lig.)	8,193	
	North Dakota (lig.)	2,681	
	Wyoming	1,381	
Cambria & Indiana	Pennsylvania	3,362	3,362
Carbon County	Utah	713	713
Chesapeake & Ohio	Kentucky	21,128	52,665
	West Virginia	31,537	
Chicago & Eastern Illinois	Illinois	1,591	1,591
Chicago & Illinois Midland	Illinois	407	407
Chicago, Milwaukee, St. Paul and Pacific	Indiana	3,808	3,926
	North Dakota (lig.)	118	
Chicago & North Western	Illinois	4,187	4,187
Chicago, Rock Island & Pacific	Illinois	1,424	1,560
	Iowa	136	
Clinchfield	Kentucky	426	6,183
	Virginia	5,757	
Colorado & Wyoming	Colorado	616	616
Denver & Rio Grande Western	Colorado	3,333	5,381
	Utah	2,048	
Erie-Lackawanna	Ohio	191	191
Gulf, Mobile & Ohio	Illinois	2,923	2,923
Illinois Central	Illinois	17,057	29,653
	Kentucky	12,596	
Interstate	Virginia	3,804	3,804
Kansas City Southern	Oklahoma	239	239
Kentucky & Tennessee	Kentucky	914	914
Lake Erie, Franklin & Clarion	Pennsylvania	229	229
Louisville & Nashville	Alabama	4,904	49,565
	Indiana	3,171	
	Kentucky	40,497	
	Tennessee	982	
	Virginia	11	
Mary Lee	Alabama	731	731
Missouri Illinois	Illinois	1,503	1,503
Missouri-Kansas-Texas	Kansas	804	1,243
	Missouri	431	
	Oklahoma	8	
Missouri Pacific	Arkansas	276	7,079
	Illinois	6,629	
	Oklahoma	174	
Monon	Indiana	71	71
Monongahela	West Virginia	7,574	7,574
Montour	Pennsylvania	2,709	2,709
Norfolk & Western	Iowa	43	67,005
	Kentucky	11,040	
	Missouri	257	
	Ohio	4,724	
	Virginia	18,647	
	West Virginia	32,294	
Penn Central (includes coal shipped over Kanawha & Michigan, Kelley's Creek, Toledo & Ohio Central, and Zanesville & Western)	Illinois	2,216	46,339
	Indiana	8,584	
	Ohio	12,469	
	Pennsylvania	19,156	
	West Virginia	3,914	
Pittsburgh & Shawmut	Pennsylvania	1,978	1,978
St. Louis-San Francisco	Alabama	319	2,308
	Arkansas	3	
	Kansas	336	
	Oklahoma	1,650	
Soo Line	North Dakota (lig.)	425	425
Southern	Alabama	3,504	15,242
	Indiana	2,129	
	Kentucky	563	
	Tennessee	4,302	
	Virginia	4,744	

See footnote at end of table.

Table 29.—Bituminous coal and lignite loaded for shipment by railroads and waterways in the United States, in 1972, as reported by mine operators—Continued

(Thousand short tons)

Route	State	By State	Total for route
RAILROAD—Continued			
Tennessee	Tennessee	681	681
Tennessee Coal, Iron & Railroad Co	Alabama	1,663	1,663
Union Pacific	Colorado	888	5,656
	Wyoming	4,768	
Unity	Pennsylvania	496	496
Utah	Utah	1,116	1,116
Western Maryland	Maryland	687	4,577
	Pennsylvania	406	
	West Virginia	3,484	
Woodward Iron Company	Alabama	887	887
Total railroad shipments		394,014	394,014
WATERWAY			
Allegheny River	Pennsylvania	863	863
Arkansas River	Arkansas	145	513
	Oklahoma	368	
Black Warrior River	Alabama	2,944	2,944
Green River	Kentucky	14,186	14,186
Illinois River	Illinois	392	392
Kanawha River	West Virginia	4,679	4,679
Monongahela River	Pennsylvania	15,504	24,746
	West Virginia	9,242	
Ohio River	Illinois	2,491	19,613
	Indiana	2,028	
	Kentucky	5,175	
	Ohio	6,228	
	West Virginia	3,691	
Tennessee River	Alabama	1,254	1,889
	Tennessee	635	
Total waterway shipments		69,825	69,825
Total loaded at mines for shipment by railroads and waterways		463,839	463,839
Shipped by truck from mine to final destination		65,633	65,633
Coal transported to electric utility plants adjacent to or near the mine		61,878	61,878
All other [1]		4,036	4,036
Total production		595,386	595,386

[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 shipped by slurry pipeline.

Table 30.—Bituminous coal and lignite shipped by unit train in the United States

(Thousand short tons)

State	1971	1972
Alabama	3,373	4,253
Arkansas	89	--
Colorado	1,692	1,210
Illinois	17,329	21,777
Indiana	2,351	3,048
Iowa	--	378
Kansas	762	214
Kentucky:		
Eastern	11,164	9,522
Western	7,730	6,706
Total	18,894	16,228
Maryland	210	60
Montana (bituminous)	6,526	7,698
New Mexico	1,034	623
North Dakota (lignite)	923	1,577
Ohio	16,688	18,063
Oklahoma	910	462
Pennsylvania	19,125	18,228
Tennessee	1,343	1,171
Utah	1,825	1,905
Virginia	2,525	3,301
West Virginia	26,793	33,449
Wyoming	441	2,889
Total [1]	122,832	136,534

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

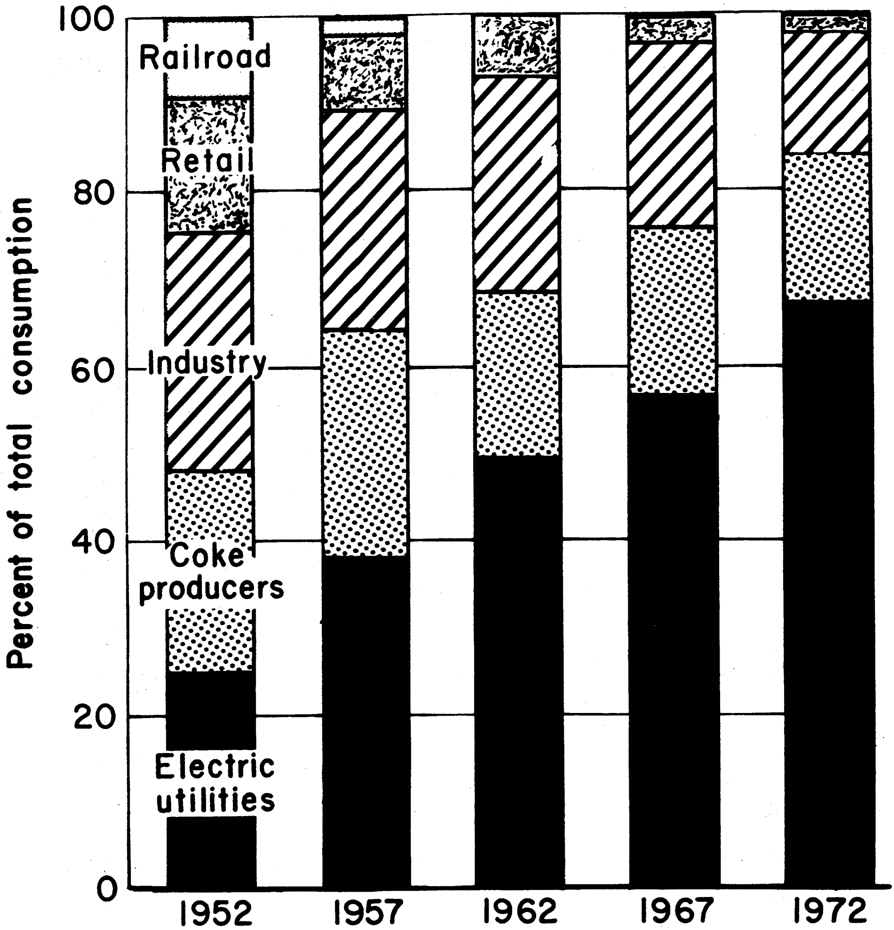

Figure 5.—Percentage of total consumption of bituminous coal and lignite by consumer class and retail deliveries in the United States.

Table 31.—Consumption of bituminous coal and lignite, by consumer class, with 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: Beehive coke plants	Oven coke plants	Steel and rolling mills [3]	Other manufacturing and mining industries [4]	Retail deliveries to other consumers [5]	Total of classes shown [6]
1968	294,739	417	1,268	89,497	5,657	92,028	15,224	498,830
1969	308,461	313	1,158	91,743	5,560	85,374	14,666	507,275
1970	318,921	298	1,428	94,581	5,410	82,909	12,072	515,619
1971:								
January	30,804	2	107	8,169	729	8,427	1,786	50,024
February	27,127	--	120	7,298	680	7,660	1,340	44,225
March	28,040	5	126	8,255	693	7,777	876	45,772
April	25,103	25	110	8,047	555	6,810	490	41,140
May	24,808	26	125	8,182	465	6,011	230	39,847
June	28,154	30	126	7,615	392	5,527	510	42,354
July	28,004	29	110	6,895	330	5,102	517	40,987
August	27,783	26	97	5,067	351	4,564	670	38,558
September	27,052	31	95	5,722	362	4,102	950	38,314
October	25,167	17	90	5,633	288	3,984	1,224	36,403
November	25,944	8	71	4,597	318	4,153	1,315	36,406
December	28,294	8	101	6,051	397	4,538	1,443	40,832
Total	326,280	207	1,278	81,531	5,560	68,655	11,351	494,862
1972:								
January	30,074	1	82	6,790	510	5,190	1,304	43,951
February	28,790	--	86	6,689	540	6,075	998	43,178
March	28,261	2	85	7,373	492	6,817	743	43,773
April	25,908	11	85	7,338	416	5,998	402	40,158
May	26,648	20	82	7,557	378	5,580	323	40,588
June	27,600	23	84	7,126	244	5,166	262	40,505
July	30,088	18	79	7,276	290	4,970	350	43,071
August	31,470	24	87	7,273	298	4,969	577	44,698
September	28,800	20	88	6,952	306	4,996	840	42,002
October	28,967	17	87	7,258	381	5,438	902	43,050
November	29,720	19	102	7,063	457	5,772	971	44,104
December	32,286	8	112	7,518	538	6,160	1,076	47,698
Total	348,612	163	1,059	86,213	4,850	67,131	8,748	516,776

[1] Federal Power Commission.
[2] Bureau of the 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. Revised.
[5] Estimates based upon reports collected from a selected list of representative retailers. Includes some coal shipped by truck from mine to final destination. Revised.
[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 yearend 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 32.—Stocks of bituminous coal and lignite in the hands of commercial consumers and in the retail dealers' yards in the United States, 1972

Date	Total stocks (thousand short tons)	Day's supply at current rate of consumption on date of stocktaking: Electric power utilities	Manufacturing and mining industries: Oven coke plants	Steel and rolling mills	Other manufacturing and mining industries	Retail dealers	Average
Jan. 31	92,908	78	36	21	51	7	65
Feb. 29	93,648	77	35	20	42	8	62
Mar. 31	97,855	87	36	27	43	10	69
Apr. 30	103,701	97	38	29	50	17	77
May 31	110,597	105	41	38	52	24	84
June 30	114,493	104	43	47	49	24	85
July 31	109,733	95	35	43	51	21	79
Aug. 31	112,865	94	36	37	51	14	78
Sept. 30	114,346	101	38	36	46	9	81
Oct. 31	117,992	108	39	32	41	8	84
Nov. 30	118,526	102	40	26	37	7	80
Dec. 31	114,351	94	37	22	36	6	74

Table 33.—Distribution of bituminous coal and lignite, in 1972, 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	380,262	96,248	9,530	[1] 69,436	367	1,521
Shipments to all destinations in the United States, Canada, and Mexico by specific method of movement and consumer use:						
Method of movement:						
All-rail	193,391	52,073	4,894	[1] 39,085	--	--
River and ex-river	83,380	23,852	548	5,537	--	--
Great Lakes [2]	19,282	14,773	1,434	8,096	--	--
Tidewater [3]	1,091	3,935	--	58	--	--
Truck	47,067	1,582	2,654	16,660	--	--
Tramway, conveyor, and private railroad	36,051	33	--	--	--	--
Method of movement and/or consumer uses unknown	--	--	--	--	367	1,521
Total	380,262	96,248	9,530	[1] 69,436	367	1,521

Shipments	Canadian Great Lakes commercial docks [4]	U.S. Great Lakes dock storage [4]	U.S. tidewater dock storage [4]	Overseas exports [5] [6]	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	412	−266	--	36,607	1,097	595,214
Shipments to all destinations in the United States, Canada, and Mexico by specific method of movement and consumer use:						
Method of movement:						
All-rail	--	--	--	--	--	[1] 289,443
River and ex-river	--	--	--	--	--	113,317
Great Lakes [2]	--	--	--	--	--	43,585
Tidewater [3]	--	--	--	--	--	5,084
Truck	--	--	--	--	--	67,963
Tramway, conveyor, and private railroad	--	--	--	--	--	36,084
Method of movement and/or consumer uses unknown	412	−266	--	36,607	1,097	39,738
Total	412	−266	--	36,607	1,097	595,214

[1] Includes overseas exports from producing districts 13, 14, and 20.
[2] 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.
[3] Excludes overseas exports for which consumer uses are not available.
[4] Consumer use unknown.
[5] Excludes Canada; consumer use unknown.
[6] Excludes overseas exports from producing districts 13, 14, and 20.

Table 34.—Distribution of bituminous coal and lignite, in 1972, by district of origin and consumer use

(Thousand short tons)

District of origin [1]	Electric utilities	Coke and gas plants	Retail dealers	All others	Railroad fuel	Used at mines and sales to employees
1	34,346	4,358	301	4,221	22	222
2	8,923	21,016	282	4,505	--	16
3 and 6	36,836	2,487	247	4,087	24	11
4	41,731	--	1,192	9,067	51	44
7	746	15,567	363	1,194	62	882
8	71,313	36,910	4,455	22,497	130	99
9	49,374	--	181	3,323	14	--
10	53,137	4,280	991	8,443	35	45
11	20,286	68	289	5,407	12	1
12	703	--	--	61	--	--
13	13,049	6,334	277	[2] 2,464	--	--
14	--	309	--	[2] 442	--	--
15 [3]	7,430	138	46	293	1	--
16	561	--	15	3	--	2
17	2,566	2,847	264	522	--	--
18	10,134	--	--	23	--	--
19	10,637	33	105	631	4	5
20	1,611	1,901	403	[2] 1,096	2	24
21	6,032	--	87	701	1	170
22 and 23	10,797	--	32	456	9	--
Total	380,262	96,248	9,530	69,436	367	1,521
District of origin [1]	**Canadian Great Lakes commercial docks [4]**	**U.S. Great Lakes dock storage [4]**	**U.S. tidewater dock storage [4]**	**Overseas exports [5]**	**Net change in mine inventory**	**Total**
1	119	--	--	1,890	24	45,503
2	49	−12	--	--	13	34,792
3 and 6	145	2	--	1,597	−133	45,303
4	8	−78	--	--	199	52,214
7	--	1	--	14,698	−15	33,498
8	91	−161	--	18,422	415	154,171
9	--	−8	--	--	70	52,954
10	--	−10	--	--	267	67,188
11	--	--	--	--	38	26,101
12	--	--	--	--	--	764
13	--	--	--	(6)	78	22,202
14	--	--	--	(6)	−8	743
15	--	--	--	--	64	7,972
16	--	--	--	--	−1	580
17	--	--	--	--	20	6,219
18	--	--	--	--	36	10,243
19	--	--	--	--	67	11,482
20	--	--	--	(6)	−22	5,015
21	--	--	--	--	−15	6,976
22 and 23	--	--	--	--	--	11,294
Total	412	−266	--	36,607	1,097	595,214

[1] Producing districts are defined in: Bureau of Mines Bituminous Coal and Lignite Distribution Calendar Year 1972, Mineral Industry Survey, April 9, 1973, 39 pp.
[2] Includes overseas exports.
[3] Excludes Texas.
[4] Consumer use unknown.
[5] Excludes Canada; consumer use unknown.
[6] Included with "All others."

Table 35.—Distribution of bituminous coal and lignite, in 1972, by destination and consumer use

(Thousand short tons)

Destination	Total	Electric utilities	Coke and gas plants	Retail dealers	All others [1]
New England:					
Massachusetts	147	26	--	13	108
Connecticut	109	54	--	--	55
Maine, New Hampshire, Vermont, Rhode Island	1,266	1,229	--	8	29
Middle Atlantic:					
New York	13,177	5,790	4,118	51	3,218
New Jersey	1,303	1,259	--	2	42
Pennsylvania	64,518	35,480	23,191	446	5,401
East North Central:					
Ohio	67,795	42,238	12,785	1,236	11,536
Indiana	46,618	26,090	13,799	847	5,882
Illinois	42,028	32,294	3,243	1,415	5,076
Michigan	35,085	21,424	5,378	649	7,634
Wisconsin	14,978	10,885	432	784	2,877
West North Central:					
Minnesota	8,639	6,674	608	303	1,054
Iowa	6,956	5,429	--	78	1,449
Missouri	15,810	13,714	318	96	1,682
North Dakota and South Dakota	5,834	5,295	--	132	407
Nebraska and Kansas	2,348	2,003	--	56	289
South Atlantic:					
Delaware and Maryland	9,744	5,408	3,580	30	726
District of Columbia	458	146	--	25	287
Virginia	8,027	4,894	--	416	2,717
West Virginia	32,459	22,752	5,044	271	4,392
North Carolina	21,489	19,696	--	370	1,423
South Carolina	6,915	5,480	--	214	1,221
Georgia and Florida	17,815	17,355	--	62	398
East South Central:					
Kentucky	27,389	23,460	1,631	319	1,979
Tennessee	21,390	18,894	174	450	1,872
Alabama and Mississippi	30,064	19,388	8,033	125	2,518
West South Central:					
Arkansas, Louisiana, Oklahoma, and Texas	930	--	883	4	43
Mountain:					
Colorado	5,516	3,655	1,059	233	569
Utah	3,017	592	1,714	168	543
Montana and Idaho	1,281	753	--	210	318
Wyoming	5,152	4,903	--	40	209
New Mexico	6,851	6,844	--	--	7
Arizona and Nevada	4,513	4,354	--	1	158
Pacific:					
Washington and Oregon	2,865	2,597	--	65	203
California	1,780	--	1,767	4	9
Alaska	707	264	--	27	416
Canada [2]	17,740	8,821	7,593	293	1,033
Mexico	466	--	385	--	81
Destinations not revealable	[3] 1,702	122	513	87	[3] 980
Destinations and/or consumer uses not available:					
Great Lakes movement:					
Canadian commercial docks	412	--	--	--	--
Vessel fuel	595	--	--	--	--
U.S. dock storage	−266	--	--	--	--
Tidewater movement:					
Overseas exports (except Canada)	[4] 36,607	--	--	--	--
Bunker fuel	--	--	--	--	--
U.S. dock storage	--	--	--	--	--
Railroad fuel:					
U.S. companies	357	--	--	--	--
Canadian companies	10	--	--	--	--
Coal used at mines and sales to employees	1,521	--	--	--	--
Net change in mine inventory	1,097	--	--	--	--
Total	595,214	--	--	--	--

[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.
[3] Includes overseas exports from producing districts 13, 14, and 20.
[4] Excludes overseas exports from producing districts 13, 14, and 20.

Table 36.—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				
	1968	1969	1970	1971	1972	1968	1969	1970	1971	1972
Total	545,319	559,880	597,992	553,123	595,214	100.0	100.0	100.0	100.0	100.0
New England	6,956	5,659	3,568	2,445	1,522	1.3	1.0	.6	.4	.2
Massachusetts	2,872	2,225	608	227	147	.5	.4	.1	(1)	(1)
Connecticut	3,013	2,295	1,832	1,271	109	.6	.4	.3	.2	(1)
Maine, New Hampshire, Vermont, and Rhode Island	1,071	1,139	1,128	947	1,266	.2	.2	.2	.2	.2
Middle Atlantic	91,289	89,485	90,992	77,552	78,998	16.7	16.0	15.2	14.0	13.2
New York	24,562	24,324	23,032	15,596	13,177	4.5	4.3	3.9	2.8	2.2
New Jersey	6,837	5,500	4,951	2,974	1,303	1.2	1.0	.8	.5	.2
Pennsylvania	58,890	59,661	63,009	58,982	64,518	11.0	10.7	10.5	10.7	10.8
East North Central	195,484	199,349	206,011	187,969	206,504	35.8	35.6	34.5	34.0	34.7
Ohio	59,912	62,160	67,375	63,116	67,795	11.0	11.1	11.3	11.4	11.4
Indiana	40,245	41,299	42,385	38,599	46,618	7.4	7.4	7.1	7.0	7.8
Illinois	43,465	45,244	42,310	38,289	42,028	8.0	8.1	7.1	6.9	7.1
Michigan	36,787	35,674	36,633	32,625	35,085	6.7	6.3	6.1	5.9	5.9
Wisconsin	15,075	14,972	17,308	15,340	14,978	2.7	2.7	2.9	2.8	2.5
West North Central	27,350	30,337	35,098	35,407	39,587	5.0	5.4	5.9	6.4	6.7
Minnesota	7,332	8,100	8,769	8,313	8,639	1.3	1.4	1.5	1.5	1.4
Iowa	5,477	5,673	6,159	6,239	6,956	1.0	1.0	1.0	1.1	1.2
Missouri	9,400	11,098	13,397	13,358	15,810	1.7	2.0	2.3	2.4	2.7
North Dakota and South Dakota	3,781	3,996	4,799	5,272	5,834	.7	.7	.8	1.0	1.0
Nebraska and Kansas	1,360	1,470	1,974	2,225	2,348	.3	.3	.3	.4	.4
South Atlantic	88,413	89,574	91,559	90,354	96,907	16.2	16.0	15.3	16.3	16.3
Delaware and Maryland	14,777	15,008	13,928	11,599	9,744	2.7	2.7	2.3	2.1	1.6
District of Columbia	[2] 887	1,235	1,113	598	458	[2] .2	.2	.2	.1	.1
Virginia	14,526	12,994	11,065	9,258	8,027	2.7	2.3	1.9	1.7	1.3
West Virginia	24,564	24,356	24,395	26,606	32,459	4.5	4.4	4.1	4.8	5.5
North Carolina	16,912	18,711	21,696	19,779	21,489	3.1	3.3	3.6	3.6	3.6
South Carolina	4,695	5,319	6,143	6,219	6,915	.8	1.0	1.0	1.1	1.2
Georgia and Florida	12,052	11,951	13,219	16,295	17,815	2.2	2.1	2.2	2.9	3.0
East South Central	60,487	62,730	69,185	72,191	78,843	11.1	11.2	11.6	13.0	13.2
Kentucky	18,811	20,355	23,672	25,590	27,389	3.4	3.6	4.0	4.6	4.6
Tennessee	16,833	16,793	18,315	18,907	21,390	3.1	3.0	3.1	3.4	3.6
Alabama and Mississippi	24,843	25,582	27,198	27,694	30,064	4.6	4.6	4.5	5.0	5.0
West South Central: Arkansas, Louisiana, Oklahoma, and Texas	976	929	1,144	887	930	.2	.2	.2	.2	.2
Mountain	14,868	16,418	20,232	21,581	26,330	2.7	2.9	3.4	3.9	4.4
Colorado	4,967	4,687	5,136	4,475	5,516	.9	.8	.9	.8	.9
Utah	2,836	2,978	3,010	2,993	3,017	.5	.5	.5	.5	.5
Montana and Idaho	1,042	1,063	1,065	1,348	1,281	.2	.2	.2	.3	.2
Wyoming	2,702	3,324	3,809	3,728	5,152	.5	.6	.6	.7	.9
New Mexico	2,392	3,263	6,032	6,713	6,851	.4	.6	1.0	1.2	1.1
Arizona and Nevada	929	1,103	1,180	2,324	4,513	.2	.2	.2	.4	.8
Pacific	2,546	2,683	2,691	3,329	4,645	.5	.5	.5	.6	.8
Washington and Oregon	449	452	374	1,482	2,865	.1	.1	.1	.3	.5
California	2,097	2,231	2,317	1,847	1,780	.4	.4	.4	.3	.3
Alaska	804	672	612	748	707	.1	.1	.1	.1	.1
Canada [3]	16,746	16,752	18,673	17,522	18,162	3.1	3.0	3.1	3.2	3.1

See footnotes at end of table.

Table 36.—Total bituminous coal and lignite shipments and percent of grand total shipments, by geographic division and State of destination—Continued

Geographic division and State of destination	Thousand short tons					Percent of total				
	1968	1969	1970	1971	1972	1968	1969	1970	1971	1972
Mexico	74	84	163	291	466	(1)	(1)	(1)	0.1	0.1
Destinations not revealable	2,138	2,175	[4] 2,969	[5] 2,179	[6] 1,702	.4	.4	[4] .5	[5] .4	[6] .3
U.S. railroad fuel	976	827	721	528	357	.2	.1	.1	.1	.1
U.S. Great Lakes storage	−239	−446	−16	−263	−266	(1)	−.1	(1)	(1)	(1)
U.S. tidewater dock storage	−5	--	--	--	--	(1)	--	--	--	--
Vessel fuel	879	951	1,072	713	595	.2	.2	.2	.1	.1
Bunker fuel	--	--	--	--	--	--	--	--	--	--
Overseas exports	33,998	39,361	[7] 51,766	[8] 37,810	[9] 36,607	6.2	7.0	[7] 8.6	[8] 6.8	[9] 6.1
Coal used at mines and sales to employees	1,496	1,450	1,486	1,483	1,521	.3	.3	.2	.3	.2
Net change in mine inventory	83	890	66	397	1,097	(1)	.2	(1)	.1	.2

[1] Less than 0.1%.
[2] A considerable block of tonnage is included under "Destinations not revealable."
[3] Includes shipments to Canadian Great Lakes commercial docks and railroad companies.
[4] Includes overseas exports from producing districts 13 and 17.
[5] Includes overseas exports from producing districts 13, 14, 17 and 20.
[6] Includes overseas exports from producing districts 13, 14 and 20.
[7] Excludes overseas exports from producing districts 13 and 17.
[8] Excludes overseas exports from producing districts 13, 14, 17 and 20.
[9] Excludes overseas exports from producing districts 13, 14 and 20.

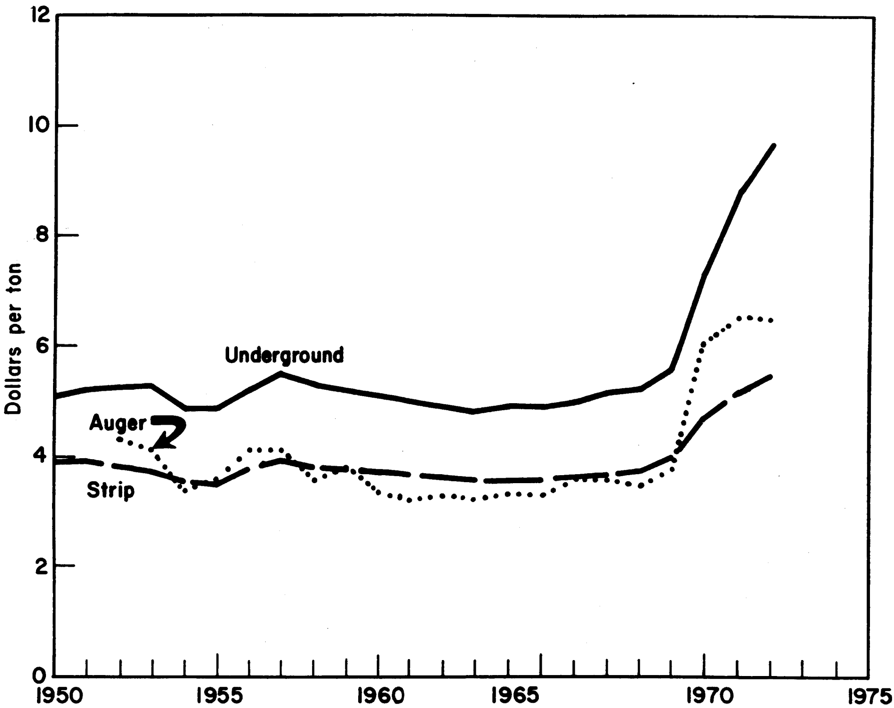

Figure 6.—Average value per ton f.o.b. mines, of bituminous coal and lignite produced in the United States, by type of mining.

Table 37.—Average value per ton, f.o.b. mine, of bituminous coal and lignite produced, by State

State	1971				1972			
	Underground	Strip	Auger	Total	Underground	Strip	Auger	Total
Alabama	$11.96	$5.85	$4.90	$8.15	$14.20	$7.01	$6.18	$9.63
Alaska	--	W	--	W	--	W	--	W
Arizona	--	W	--	W	--	W	--	W
Arkansas	12.00	10.01	--	10.30	12.50	10.90	--	10.93
Colorado	7.80	3.91	--	6.34	8.34	4.10	--	6.45
Illinois	5.96	4.95	--	5.46	6.83	5.49	--	6.14
Indiana	6.61	5.05	--	5.18	6.62	5.51	--	5.58
Iowa	4.82	4.54	--	4.66	4.80	4.91	--	4.86
Kansas	--	5.72	--	5.72	--	6.39	--	6.39
Kentucky	7.88	5.24	6.16	6.49	8.31	5.38	6.20	6.81
Maryland	5.32	6.35	6.50	6.25	4.42	5.56	5.71	5.46
Missouri	--	4.87	--	4.87	--	5.20	--	5.20
Montana:								
Bituminous	9.33	1.79	--	1.79	9.74	2.00	--	2.01
Lignite	--	2.27	--	2.27	--	2.45	--	2.45
Total	9.33	1.79	--	1.82	9.74	2.01	--	2.03
New Mexico	8.05	2.61	--	3.26	10.42	2.66	--	3.61
North Dakota (lignite)	--	1.91	--	1.91	--	2.02	--	2.02
Ohio	6.75	4.75	4.35	5.24	7.41	5.29	4.69	5.96
Oklahoma	14.41	5.98	8.50	6.72	15.00	7.01	--	7.28
Pennsylvania	9.88	6.41	6.04	8.52	10.39	6.86	6.37	9.14
Tennessee	6.99	5.99	6.85	6.40	7.56	6.83	7.70	7.23
Texas	--	W	--	W	--	W	--	W
Utah	7.37	8.00	--	7.37	8.93	8.00	--	8.93
Virginia	9.45	5.58	5.66	8.32	11.56	6.70	6.46	10.11
Washington	13.55	6.52	--	6.72	16.40	6.51	--	6.61
West Virginia	10.07	7.49	8.53	9.54	10.90	7.54	7.95	10.31
Wyoming	6.25	3.35	2.20	3.39	4.89	3.69	--	3.74
Total	8.87	5.19	6.57	7.07	9.70	5.48	6.54	7.66

W Withheld to avoid disclosing individual company confidential data.

Table 38.—Average value per ton, f.o.b. mine, of bituminous coal and lignite produced, by District

District	1971				1972			
	Underground	Strip	Auger	Total	Underground	Strip	Auger	Total
1. Eastern Pennsylvania	$10.08	$6.49	$6.26	$8.12	$9.60	$6.92	$6.66	$8.25
2. Western Pennsylvania	9.53	6.09	5.61	8.78	10.79	6.38	5.34	9.93
3. Northern West Virginia	7.73	6.12	5.53	7.36	8.55	6.84	6.36	8.16
4. Ohio	6.75	4.75	4.35	5.24	7.41	5.29	4.69	5.96
5. Michigan	--	--	--	--	--	--	--	--
6. Panhandle	6.60	4.56	--	6.55	7.51	6.50	6.50	7.49
7. Southern Numbered 1	13.82	10.22	10.02	13.21	14.87	11.40	11.88	14.45
8. Southern Numbered 2	9.32	6.31	6.67	8.18	10.19	6.41	6.47	8.86
9. West Kentucky	5.46	4.50	5.25	4.83	5.97	4.81	5.64	5.23
10. Illinois	5.96	4.95	--	5.46	6.83	5.49	--	6.14
11. Indiana	6.61	5.05	--	5.18	6.62	5.51	--	5.58
12. Iowa	4.82	4.54	--	4.66	4.80	4.91	--	4.86
13. Southeastern	11.30	5.83	5.05	7.97	13.40	6.98	6.18	9.43
14. Arkansas-Oklahoma	13.99	9.13	8.50	10.53	14.79	8.37	--	9.04
15. Southwestern	--	5.16	--	5.16	--	4.86	--	4.86
16. Northern Colorado	5.25	--	--	5.25	5.17	--	--	5.17
17. Southern Colorado	8.18	3.91	--	6.71	9.46	4.11	--	7.25
18. New Mexico	--	2.62	--	2.62	--	2.68	--	2.68
19. Wyoming	6.25	3.35	2.20	3.39	4.89	3.69	--	3.74
20. Utah	7.37	8.00	--	7.37	8.93	8.00	--	8.93
21. North-South Dakota	--	1.91	--	1.91	--	2.02	--	2.02
22. Montana	9.33	1.79	--	1.82	9.74	2.01	--	2.03
23. Washington	13.55	7.16	--	7.27	16.40	6.99	--	7.07
Total	8.87	5.19	6.57	7.07	9.70	5.48	6.54	7.66

Table 39.—Production and average value per ton in 1972, f.o.b. mine, of bituminous coal and lignite sold in open market and not sold in open market, by State

(Thousand short tons)

State	Production			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	16,144	4,670	20,814	$8.46	$13.66	$9.63
Alaska	668	--	668	W	--	W
Arizona	2,954	--	2,954	W	--	W
Arkansas	428	--	428	10.93	--	10.93
Colorado	4,532	990	5,522	4.95	13.36	6.45
Illinois	62,956	2,566	65,523	6.01	9.28	6.14
Indiana	25,949	--	25,949	5.58	--	5.58
Iowa	807	44	851	4.88	4.55	4.86
Kansas	1,227	--	1,227	6.39	--	6.39
Kentucky	115,683	5,504	121,187	6.55	12.14	6.81
Maryland	1,640	--	1,640	5.46	--	5.46
Missouri	4,551	--	4,551	5.20	--	5.20
Montana:						
Bituminous	7,899	--	7,899	2.01	--	2.01
Lignite	322	--	322	2.45	--	2.45
Total	8,221	--	8,221	2.03	--	2.03
New Mexico	7,528	720	8,248	3.00	10.01	3.61
North Dakota (lignite)	6,632	--	6,632	2.02	--	2.02
Ohio	50,125	843	50,967	5.96	6.23	5.96
Oklahoma	2,624	--	2,624	7.28	--	7.28
Pennsylvania	56,686	19,254	75,939	8.06	12.32	9.14
Tennessee	11,260	--	11,260	7.23	--	7.23
Texas	--	4,045	4,045	--	W	W
Utah	2,768	2,034	4,802	7.34	11.08	8.93
Virginia	33,479	549	34,028	10.03	15.10	10.11
Washington	2,634	--	2,634	6.61	--	6.61
West Virginia	116,528	7,215	123,743	10.12	13.39	10.31
Wyoming	7,679	3,250	10,928	4.02	3.10	3.74
Total or average [1]	543,702	51,684	595,386	7.35	10.95	7.66

W Withheld to avoid disclosing individual company confidential data.
[1] Data may not add to totals shown because of independent rounding.

Table 40.—Shipments of bituminous coal and lignite by average sulfur content by consumer use in 1972

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 and Canada)	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	20,354	3,290	2,506	886	1,628	28,664	2.2	0.9	1.9	2.1	1.7	2.0
2. Western Pennsylvania	5,237	14,914	3,126	2,670	724	26,671	2.1	1.5	1.7	1.7	2.3	1.7
3. Northern West Virginia	19,104	2,156	2,100	859	3,216	27,435	2.7	1.2	2.4	2.0	1.8	2.5
4. Ohio	33,625	--	5,633	1,242	--	40,500	3.5	--	3.0	2.9	--	3.4
5. Michigan	--	--	--	--	--	--	--	--	--	--	--	--
6. Panhandle	8,874	--	271	179	--	9,324	3.9	--	3.0	2.8	--	3.9
7. Southern Numbered 1	439	6,939	427	274	10,175	18,254	.8	.7	.8	1.0	.7	.7
8. Southern Numbered 2	28,765	16,950	5,810	10,286	7,095	68,906	1.1	.8	.9	.9	.8	.9
9. West Kentucky	43,883	--	2,144	1,020	--	47,047	4.6	--	3.7	3.7	--	4.0
10. Illinois	44,158	2,782	7,190	1,459	--	55,589	3.4	.8	2.8	2.9	--	3.2
11. Indiana	16,335	--	4,373	11	--	20,719	3.4	--	3.4	3.9	--	3.4
12. Iowa	702	--	--	18	--	720	3.4	--	--	4.0	--	3.4
13. Southeastern	7,982	4,107	831	193	247	13,360	1.7	1.0	2.0	1.1	1.3	1.3
14. Arkansas-Oklahoma	--	376	191	--	210	777	--	1.3	1.6	--	1.5	1.3
15. Southwestern	6,922	58	100	212	--	7,292	4.9	.5	4.1	3.8	--	4.8
16. Northern Colorado	556	--	16	2	--	574	.5	--	.3	.3	--	.5
17. Southern Colorado	1,871	1,720	239	23	192	4,045	.6	.6	.5	.7	.5	.6
18. New Mexico	10,157	--	10	1	--	10,168	.6	--	.5	.5	--	.6
19. Wyoming	9,135	34	479	28	--	9,676	.6	.7	.7	.6	--	.6
20. Utah	229	2,152	994	20	115	3,510	.7	.6	.6	.7	.8	.7
21. North-South Dakota	4,073	--	511	26	--	4,610	.9	--	1.0	1.0	--	.9
22. Montana	2,686	--	7	7	--	2,700	.9	--	1.1	.4	--	.9
23. Washington	668	--	29	--	--	697	1.5	--	.5	--	--	1.5
Total or average	265,755	55,478	36,987	19,416	23,602	401,238	2.9	1.0	2.3	1.6	1.0	2.3

[1] Total shipments by producers reporting sulfur content (67% of total U.S. production).

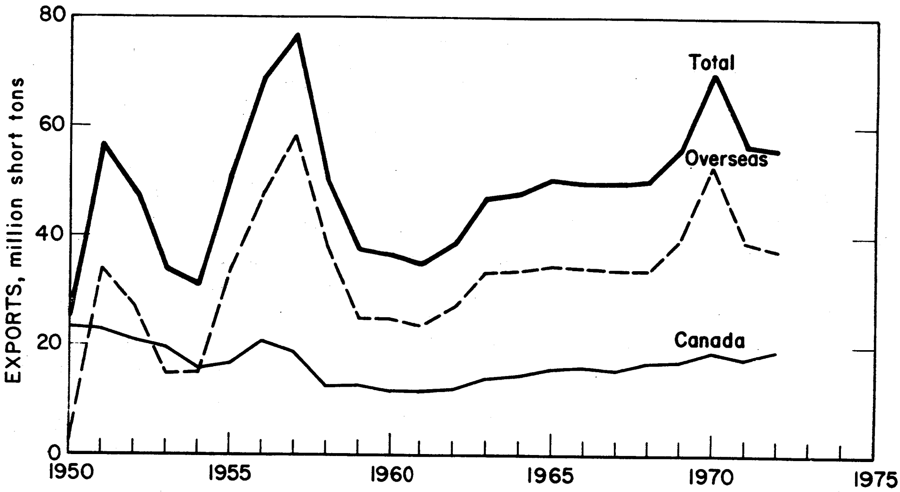

Figure 7.—Exports of bituminous coal and lignite from the United States to Canada and overseas.

Table 41.—Exports of bituminous coal, by country group
(Thousand short tons and thousand dollars)

Country group	1970 Quantity	1970 Value	1971 Quantity	1971 Value	1972 Quantity	1972 Value
Canada (including Newfoundland and Mexico)	18,846	197,934	17,852	208,795	18,627	264,575
Overseas (all other countries):						
West Indies and Central America	1	10	--	--	--	--
Bermuda, Greenland, Miquelon, St. Pierre Islands	2	44	(1)	10	1	17
South America	2,920	40,929	2,673	49,092	2,651	51,497
Europe	21,503	303,352	16,403	280,943	16,679	307,647
Asia	27,649	408,171	19,705	352,644	18,002	347,496
Africa	(1)	1	--	--	--	--
Oceania	23	349	(1)	(1)	(1)	(1)
Total	52,098	r 752,856	38,781	682,689	37,333	706,657
Grand total	70,944	r 950,790	56,633	891,484	55,960	971,232

r Revised.
[1] Less than ½ unit.

Table 42.—Bituminous coal exported from the United States, by country [1]

(Thousand short tons and thousand dollars)

Country	1970		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value
Australia	23	346	(2)	(2)	--	--
Austria	65	919	--	--	--	--
Argentina	596	8,222	539	9,754	394	7,655
Belgium-Luxembourg	1,881	29,977	765	15,005	1,144	22,214
Brazil	2,020	27,691	1,869	34,619	1,917	37,067
Canada	18,673	195,133	17,565	202,922	18,161	254,243
Chile	275	4,705	207	3,843	240	5,315
France	3,346	46,177	3,106	50,623	1,575	30,632
Germany:						
East	396	5,942	77	1,448	19	411
West	5,022	65,876	2,911	43,091	2,399	39,780
Greece	--	--	65	1,130	--	--
Ireland	69	1,014	17	349	22	416
Italy	4,205	59,811	2,680	50,257	3,673	69,584
Japan	27,637	407,963	19,706	352,629	18,001	347,487
Mexico	173	2,801	285	5,835	466	10,332
Miquelon and St. Pierre Islands	2	44	2	38	--	--
Netherlands	2,112	27,941	1,625	27,386	2,289	39,925
Norway	192	3,051	83	1,597	167	3,361
Peru	--	--	26	277	67	792
Portugal	--	--	12	243	304	5,813
Romania	70	1,380	--	--	--	--
Spain	3,153	46,971	2,556	48,562	2,139	42,928
Sweden	764	11,586	618	12,149	425	8,260
Switzerland	--	--	32	433	--	--
United Kingdom	--	--	1,669	25,897	2,381	41,793
Uruguay	26	274	31	597	32	653
Yugoslavia	225	2,681	185	2,774	142	2,530
Other	19	285	2	26	3	41
Total	70,944	950,790	56,633	891,484	55,960	971,232

[1] Amounts stated do not include fuel or bunker coal on vessels engaged in foreign trade, which aggregated 67,424 tons ($916,181) in 1970; 44,010 tons ($676,437) in 1971; and 30,718 tons ($545,146) in 1972.
[2] Less than ½ unit.

Table 43.—Bituminous coal exported from the United States, by customs district

(Thousand short tons and thousand dollars)

Customs district	1970		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value
Baltimore	4,723	62,880	3,374	53,560	3,751	66,061
Buffalo	189	1,698	21	280	13	183
Chicago	9	102	57	639	65	759
Cleveland	18,030	186,722	17,146	195,975	17,802	248,305
Detroit	69	1,050	93	1,624	94	1,676
Duluth	3	69	4	85	9	175
El Paso	64	831	53	844	42	721
Houston	--	--	--	--	1	9
Laredo	108	1,953	231	4,990	424	9,611
Los Angeles	269	3,670	385	4,975	137	1,869
Miami	(1)	3	--	--	--	--
Mobile	379	4,465	745	10,406	1,142	17,384
New Orleans	460	5,597	656	9,271	774	12,300
New York City	10	108	(1)	4	(1)	7
Norfolk	46,239	676,625	33,396	603,471	31,585	609,936
Ogdensburg	30	414	16	262	50	778
Pembina	3	61	8	166	13	256
Philadelphia	297	3,625	66	1,035	(1)	2
Port Arthur	16	263	380	3,862	57	1,180
Portland, Oreg	44	617	--	--	--	--
San Diego	1	17	(1)	(1)	(1)	3
San Francisco	(1)	(1)	--	--	(1)	2
Seattle	1	19	2	35	1	15
Tampa	(1)	1	--	--	--	--
Total	70,944	950,790	56,633	891,484	55,960	971,232

[1] Less than ½ unit.

Table 44.—Bituminous coal [1] imported for consumption in the United States, by country and customs district

Country and customs district	1970 Short tons	1970 Value (thousands)	1971 Short tons	1971 Value (thousands)	1972 Short tons	1972 Value (thousands)
Country:						
Australia	--	--	--	--	1,120	$49
Canada	36,312	$450	87,447	$1,044	44,821	621
Colombia	--	--	171	(2)	--	--
Germany, West	--	--	103	1	--	--
India	85	4	37	3	--	--
Japan	15	2	--	--	20	2
Norway	16	(2)	--	--	--	--
South Africa, Republic of	--	--	11,417	434	1,127	18
Sweden	--	--	11,861	290	--	--
United Kingdom	13	1	--	--	10	1
Other	--	--	(2)	(2)	--	--
Total	36,441	457	111,036	1,772	47,098	691
Customs district:						
Buffalo	1,416	29	977	10	--	--
Chicago	--	--	73	(2)	--	--
Detroit	104	3	47,698	525	--	--
Duluth	7,185	103	9,584	142	16,393	246
Great Falls	17,145	160	11,844	109	7,492	61
Honolulu	15	1	--	--	20	2
Houston	--	--	--	--	1,120	49
Mobile	16	(2)	--	--	--	--
New Orleans	--	--	23,278	724	1,127	18
New York City	85	4	37	3	10	1
Pembina	10,460	155	16,902	253	20,921	313
Philadelphia	13	1	--	--	--	--
Portland, Me.	2	1	--	--	15	1
Portland, Oreg	--	--	171	(2)	--	--
San Francisco	--	--	30	(2)	(2)	(2)
Seattle	--	--	442	6	--	--
Total	36,441	457	111,036	1,772	47,098	691

[1] Includes slack, culm, and lignite.
[2] Less than ½ unit.

Table 45.—Bituminous coal and lignite coal: World production by country

(Thousand short tons)

Country [1]	1970	1971	1972 p
North America:			
Canada:			
Bituminous	r 12,785	15,132	17,688
Lignite	r 3,919	3,300	3,261
Greenland: Bituminous	20	18	e 18
Mexico: Bituminous	3,262	3,915	3,598
United States:			
Bituminous	596,969	545,790	584,387
Lignite	[2] 5,963	[2] 6,402	10,999
South America:			
Argentina: Bituminous	r 679	697	745
Brazil: Bituminous (marketable)	r 2,603	2,754	2,746
Chile: Bituminous (marketable)	r 1,523	1,676	1,452
Colombia: Bituminous [3]	r 2,756	e 2,800	e 3,500
Peru: Bituminous	r 172	e 110	e 110
Venezuela: Bituminous	44	47	44
Europe:			
Albania: Lignite [4]	736	e 770	e 770
Austria: Lignite [5]	4,045	4,156	4,140
Belgium: Bituminous	8,462	8,365	8,316
Bulgaria:			
Bituminous	260	251	e 250
Lignite [4]	31,806	29,341	30,716
Czechoslovakia:			
Bituminous	r 30,935	31,639	30,358
Lignite [4]	90,150	93,466	94,327
Denmark: Lignite	149	(6)	--
France:			
Bituminous	30,326	26,274	e 22,112
Lignite	3,070	3,032	3,267
Germany, East:			
Bituminous e	1,430	1,320	1,100
Lignite [4]	287,242	289,702	273,814
Germany, West:			
Bituminous	r 117,488	117,909	104,980
Lignite	118,792	115,167	121,713
Pech	740	75	--
Greece: Lignite	r 8,703	12,085	12,764
Hungary:			
Bituminous	r 3,727	4,344	4,045
Lignite [4]	26,102	25,886	24,445
Ireland: Bituminous	r 172	99	e 85
Italy:			
Bituminous	r 325	282	166
Lignite	r 1,534	1,462	952
Poland:			
Bituminous	154,435	160,378	167,218
Lignite [4]	36,118	38,048	42,108
Romania:			
Bituminous [7]	r 7,050	7,852	e 7,330
Lignite [4]	r 15,575	15,192	e 18,600
Spain:			
Bituminous	8,756	8,610	8,820
Lignite	r 3,121	3,396	3,369
Svalbard (Spitzbergen): Bituminous [8]	r 508	480	503
Sweden: Bituminous	r 13	(6)	--
U.S.S.R.: [9]			
Bituminous	441,589	453,908	e 466,000
Lignite [4]	r 162,820	169,030	e 171,000
United Kingdom: Bituminous	r 155,259	157,625	128,328
Yugoslavia:			
Bituminous	709	779	661
Lignite [4]	30,621	33,288	33,313
Africa:			
Algeria: Bituminous [3]	r 17	4	2
Mozambique: Bituminous	387	356	370
Nigeria: Bituminous	r 40	174	376
Rhodesia, Southern: Bituminous [10]	3,495	3,409	3,045
South Africa, Republic of: Bituminous (marketable)	58,350	62,639	62,946
Swaziland: Bituminous	136	163	158
Tanzania: Bituminous	3	3	e 3
Zaire: Bituminous	112	126	141
Zambia: Bituminous	r 687	895	1,057
Asia:			
Afghanistan: Bituminous [11]	187	e 200	e 200
Burma: Bituminous	17	22	24
China, People's Republic of: Bituminous and lignite	400,000	430,000	440,000

See footnotes at end of table.

Table 45.—Bituminous coal and lignite coal: World production by country—Continued

(Thousand short tons)

Country [1]	1970	1971	1972 p
Asia—Continued			
India:			
Bituminous	r 81,234	78,814	82,421
Lignite	3,908	4,034	3,381
Indonesia: Bituminous	r 190	218	197
Iran: Bituminous	r 584	660	e 660
Japan:			
Bituminous	r 46,971	36,305	30,469
Lignite	r 483	147	112
Korea, North: Bituminous e	6,100	6,600	7,200
Lignite e	220	220	220
Mongolia:			
Bituminous	r 93	111	e 120
Lignite	r 2,111	2,188	2,275
Pakistan: Bituminous and lignite e	1,400	1,380	1,380
Philippines: Bituminous	r 46	44	43
Taiwan: Bituminous	4,931	4,516	4,313
Thailand: Lignite	441	491	380
Turkey:			
Bituminous	r 5,041	5,114	e 5,180
Lignite	r 4,400	4,648	e 4,850
Oceania:			
Australia:			
Bituminous	54,246	54,767	65,725
Lignite	26,648	25,775	26,122
New Zealand:			
Bituminous	2,421	2,163	2,237
Lignite	r 209	178	167
World total:			
Bituminous	r 1,847,545	1,810,357	1,831,447
Lignite (including Pech)	r 869,626	881,479	887,065
Mixed grades [12]	r 401,400	431,380	441,380
Total, all grades	r 3,118,571	3,123,216	3,159,892

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 Excludes production from the state of Texas.

3 May include a small amount of anthracite.

4 Includes materials reported in national sources as brown coal.

5 Available sources report only lignite production, a small amount of bituminous coal may also be produced.

6 Revised to zero.

7 Official sources report the aggregate of anthracite and bituminous, distribution to these separate grades is estimated from reported total.

8 Output from Norwegian controlled portion only; in previous editions of this chapter, a separate figure (estimated) has been reported for the portion of Svalbard controlled by the U.S.S.R. This entry has been deleted inasmuch as this production is presumably included in the total output recorded for the U.S.S.R.

9 Run of mine output.

10 Sales, for year ended August 31 of that stated.

11 Year beginning March 21 of that stated.

12 Bituminous plus lignite for the People's Republic of China and Pakistan.

Coal—Pennsylvania Anthracite

By Dorothy R. Federoff [1]

Data in this chapter refer only to anthracite or hard coal, produced in 11 counties located in the northeastern part of the Commonwealth of Pennsylvania. The anthracite region is divided geologically into four fields: Northern, Eastern Middle, Western Middle, and Southern. The area is also grouped into three trade regions: Wyoming, Lehigh, and Schuylkill.

The downward trend in the production of anthracite continued in 1972. Continued losses to competitive fuels in space-heating, a labor-shortage, and hurricane Agnes, which flooded mines and slowed both production and movement to market, contributed to the decline.

Total production of anthracite in 1972 was 7.1 million short tons, a decrease of approximately 18.6% from that of 1971. Anthracite was produced at 117 underground mines, 115 strip pits, 63 culm and silt banks, and 8 dredging operations. Of the total output, 49% was produced at strip pits, 31% at culm and silt banks, 13% at underground mines, and 7% at dredging operations. Compared with tonnages produced in 1971, underground production decreased 27%; culm and silt banks, 14%; strip production, 22%; however, dredge production increased 22%.

The average value f.o.b. preparation plants for all sizes of anthracite, excluding dredge coal, was $12.40 per ton compared with $12.08 per ton in 1971. The value of pea and larger sizes showed an increase of $0.79, averaging $17.18 per ton, and the average value of buckwheat No. 1 and smaller sizes increased $0.24 per ton to an average of $10.14 per ton. However, the total value of the 1972 reduced output was $85.3 million, a decrease of 19% from the preceding year.

Apparent consumption of anthracite in the United States was approximately 5.9 million tons compared with 7.3 million tons in 1971, a drop of 19%. Although use data are incomplete for anthracite, declines occurred in all categories except coke-making, which indicated an increase of 13% for 1972. In former years, the demand for space-heating coal created a surfeit of industrial coal, but the trend has reversed—there is an increasing demand for industrial anthracite.

Data released by the U.S. Bureau of Census, indicated that 743,451 short tons of Pennsylvania anthracite were shipped to Canada and other foreign countries, compared with 671,024 shipped in 1971. A more accurate measurement of exports can be obtained by adding the quantity shipped for use by the U.S. Armed Forces in West Germany (447,728 tons), to the tonnage reported by the Bureau of Census.

Accordingly, approximately 1,191 million tons were actually exported in 1972, compared with 1,289 million tons in 1971. Increased shipments to Canada, Europe, and South America were offset by diminished shipments to Asia and other countries.

Days worked in the anthracite region averaged 216, 23 days less than in 1971. Productivity rate per man-day increased from 6.30 tons in 1971 to 6.88 tons in 1972. The number of nonfatal accidents dropped from 478 in 1971, to 272 in 1972; but the fatalities increased to 3, compared with 2 in the preceding year.

The Bureau publishes a series of weekly reports containing estimates of weekly and monthly production based on car-loadings reported by railroads, and monthly production statements of truck shipments provided by the Commonwealth of Pennsylvania.

Legislation and Government Programs.—Federal and State Government programs in the environmental area continued through 1972 and included underground mine and refuse or culm bank-fire control, surface

[1] Minerals specialist, Division of Fossil Fuels; Assistant Directorate—Mineral Supply.

subsidence, reclamation of old strip pits, and mine-water-control projects 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 over a period of years have provided data for evaluating mine-water problems. They involve determination of the varying heights of underground mine pools, their hydrostatic pressures and possible effect upon barrier pillars and mine dams protecting active mining operations, acid mine-water drainage into surface streams and the unconsolidated valley fill.

Close surveillance of underground mine water pool levels will be maintained to provide a data base for projected environmental protection by Federal and other Government agencies. Under the closely related mine-water control program, additional phases of the project to install a comprehensive series of mine pool monitoring stations are expected in the Western Middle and Southern fields.

A total of 39 mine-water control projects, including five Health and Safety projects, were approved during recent years. Among these projects were 17 pump projects, involving the installation of 29 large-capacity deepwell pumps, and 16 surface drainage improvement projects. Approval was given to a long-term project involving a comprehensive network of permanent mine-water pool monitoring stations throughout the anthracite region.

An overall program aimed at controlling fires in anthracite and other coal refuse banks has been developed. Efforts include investigations into the causes and environmental effects of these fires, attempts at their early detection and inventorying, and development of economic techniques for quenching and removing burning coal refuse banks. As part of the program, an aerial survey (combining conventional aerial photography with airborne infrared imagery) was taken of the burning banks in the anthracite region. The pertinent photographs, scanner imagery, and physical data obtained on the size, location, and extent of burning areas within individual banks were assembled into two compendiums designed to assist in planning for and executing extinguishment operations.

The first phase of a related demonstra-

Table 1.—Salient statistics of the Pennsylvania anthracite industry

	1968	1969	1970	1971	1972
Production:					
Preparation plants ____ short tons	10,799,260	9,920,130	9,304,221	8,323,168	6,618,205
Dredges ____ do	605,920	535,369	409,354	389,609	476,792
Used at collieries for power and heat ____ do	55,653	17,417	15,823	14,548	11,298
Total production ____ do	11,460,833	10,472,916	9,729,398	8,727,325	7,106,295
Value ____ thousands	$97,245	$100,770	$105,341	$103,469	$85,251
Average sales realization per short ton on preparation plant shipments (excludes dredge coal):					
Pea and larger	$12.40	$13.56	$15.06	$16.39	$17.18
Buckwheat No. 1 and smaller	$6.87	$7.93	$8.92	$9.90	$10.14
All sizes	$8.78	$9.91	$11.03	$12.08	$12.40
Percentage of total preparation plant shipments (excludes dredge coal):					
Pea and larger	34.6	35.1	34.4	33.6	32.0
Buckwheat No. 1 and smaller	65.4	64.9	65.6	66.4	68.0
Exports [1] ____ short tons	518,159	627,492	789,499	671,024	743,451
Consumption, apparent [2] ____ do	10,160,000	8,809,000	8,248,000	7,338,000	5,915,000
Average number of days worked	217	232	234	239	p 216
Average number of men working daily	6,932	5,927	5,938	5,800	p 4,783
Output per man per day ____ short tons	7.62	7.45	7.10	6.30	p 6.88
Output per man per year ____ do	1,654	1,728	1,661	1,505	p 1,486
Quantity cut by machines ____ do	61,245	68,300	125,779	6,018	--
Quantity mined by stripping ____ do	4,696,163	4,578,732	4,541,452	4,478,350	3,483,076
Quantity loaded by machines underground ____ do	1,475,000	1,326,598	1,150,596	669,691	593,997
Distribution:					
Exports to Canada [1]	401,314	472,763	438,008	466,039	500,306
Loaded into vessels at Lake Erie [3]	204,682	209,000	154,002	51,402	39,177

p Preliminary.
[1] U.S. Department of Commerce, 1968–72 export data does not include shipments to U.S. Armed Forces. See Note, tables 4 and 25.
[2] Excludes shipments to U.S. Armed Forces.
[3] Ore and Coal Exchange, Cleveland, Ohio.

tion project aimed at extinguishing and removing a burning mine and refuse bank was completed. Being tested during this initial phase was a novel technique of simultaneously quenching burning material by surface sprinklers and a subsurface water injection system. Work under this phase was judged successful in terms of the amount of water utilized in extinguishment and material removed.

Efforts have been made to encourage the development of new technology in backfilling subsurface mine voids to prevent subsidence. Investigations have been made into a system which employs a limited number of boreholes to hydraulically inject fill materials underground. The initial borehole drilling phase of a demonstration project for backfilling abandoned anthracite mine voids was completed. A sonar caliper survey of the voids intersected during drilling operations was also carried out.

A two-phase study, encompassing refuse bank removal and subsidence monitoring, was completed in the Northern Field. In the first phase, a computerized method was developed for selecting the most economic combinations of coal mine refuse sources and underground injection sites for the purpose of the removal and subsurface disposal of these wastes.

The second phase had the objective of evaluating and developing low-cost reliable instrument systems for the detection and tracing of early subsidence activity.

Table 2.—Standard anthracite specifications approved and adopted by the Anthracite Committee, effecive July 28, 1947

Size	Round test mesh (inches)	% Oversize maximum	Undersize		Maximum impurities [1]		
			Maximum	Minimum	Slate	Bone	Ash [2]
Broken	Through 4⅜	--	--	--	1½	2	11
	Over 3¼ to 3	--	15	7½	--	--	--
Egg	Through 3¼ to 3	5	--	--	1½	2	11
	Over 2 7/16	--	15	7½	--	3	11
Stove	Through 2 7/16	7½	--	--	2	3	11
	Over 1⅝	--	15	7½	--	--	--
Chestnut	Through 1⅝	7½	--	--	3	4	11
	Over 13/16	--	15	7½	--	--	--
Pea	Through 13/16	10	--	--	4	5	12
	Over 9/16	--	15	7½	--	--	--
Buckwheat No. 1	Through 9/16	10	--	--	--	--	13
	Over 5/16	--	15	7½	--	--	--
Buckwheat No. 2 (rice)	Through 5/16	10	--	--	--	--	13
	Over 3/16	--	17	7½	--	--	--
Buckwheat No. 3 (barley)	Through 3/16	10	--	--	--	--	15
	Over 3/32	--	20	10	--	--	--
Buckwheat No. 4	Through 3/32	20	--	--	--	--	15
	Over 3/64	--	30	10	--	--	--
Buckwheat No. 5	Through 3/64	30	No Limit		--	--	16

[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.

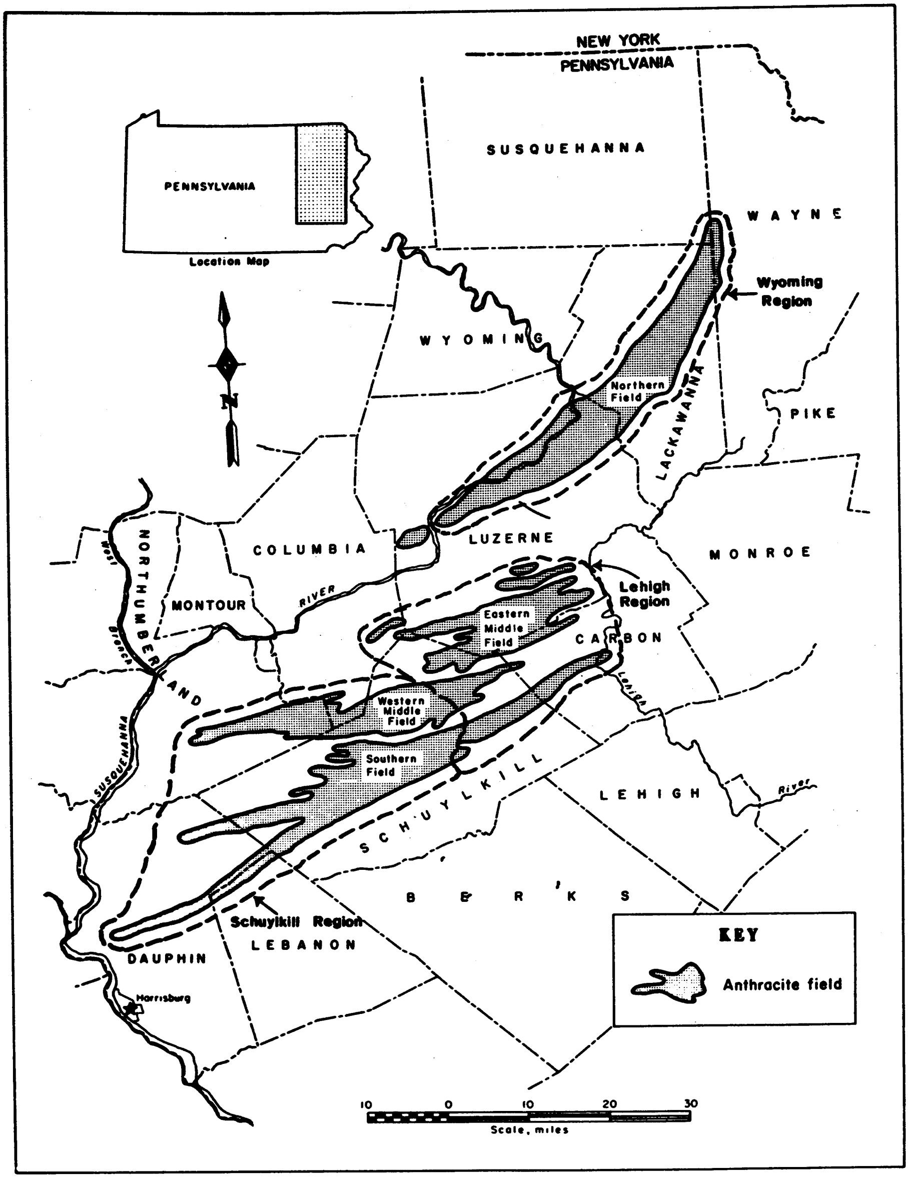

Figure 1.—Coalfields, regions, and counties of the Pennsylvania anthracite area.

DOMESTIC PRODUCTION

Production of Pennsylvania anthracite totaled 7.1 million tons in 1972, a decrease of 18.6%, or approximately 1.6 million tons less than in 1971. Underground output accounted for 13% of the total, compared with 15% in 1971; strip mining, 49% (51% in 1971); culm and silt recovery, 31% (30% in 1971); and river coal, 7% (4% in

1971). There were slight increases in the recovery of culm and silt as well as river coal—1% and 3%, respectively.

The total output by regions remained virtually at the same level as in 1971. Schuylkill region produced 57% of the total; Lehigh region, 24%; and the Wyoming region, 19%.

The two leading counties in the production of anthracite were Schuylkill County, which produced 2.9 million tons, and Luzerne County, with a production of 2.1 million tons. Other counties producing anthracite were Berks, Carbon, Columbia, Dauphin, Lackawanna, Lancaster, Northumberland, Snyder, and Sullivan.

Of total underground production, the Schuylkill region accounted for 68%; Wyoming region, 31%; and the Lehigh region 1%.

The output produced by mechanical loading of underground anthracite in 1972 declined 11%, with a decrease of 30% in loading units. Each of the two regions, Schuylkill and Wyoming, accounted for 50% of the mechanically loaded underground total. The total mechanical equipment consisted of 81 scraper loaders, 16 mobile loaders, and 46 conveyor and pit-car loaders.

Production from strip mines totaled approximately 3.5 million tons, a decrease of 22%, and accounted for 49% of the total production in 1972. Output in the Schuylkill region totaled 1,548 thousand tons, a decrease of 20%; the Lehigh region, 1,075 thousand tons, a decrease of 25%; and the Wyoming region, 860,000 tons, a decline of 23%. Of the total strip mine output, 31% was stripped in the Lehigh region, 44% in the Schuylkill region, and 25% in the Wyoming region.

Culm and silt recovery totaled 2.2 million tons, approximately 371,000 tons less than in 1971, or a decrease of 14%. Recovery by region was as follows: Lehigh region, 28% (virtually the same as in 1971); Schuylkill region, 64% (60% in 1971); and the Wyoming region, 8% (12% in 1971).

Dredging operations produced approximately 477,000 tons in 1972, an increase of 22% over that of 1971. The increase was due primarily to hurricane Agnes that flooded the region and moved fine coals and silt into rivers where it could more easily be recovered.

As the preponderant part of river coal is consumed by the producer, it is generally not as responsive to fluctuations in the general market as are the small sizes produced from other sources. Approximately 7% of the total anthracite production was dredged (4% in 1971).

In operation, at strip pits and in culm recovery in 1972, were 103 front-end loaders, 60 power shovels, and 118 draglines.

Of the total industry work force of 4,783 men in 1972, 49% were employed in the Schuylkill region, 29% in the Wyoming region, and 22% in the Lehigh region. Of total employment, 42% were employed at strip pits, 31% at preparation plants, 13% at underground workings, 7% at culm and silt banks, 6% in surface work at underground mines, and 1% on dredges. Days worked averaged 216, 23 days less than in 1971. Productivity rate per man-day increased from 6.30 tons in 1971 to 6.88 tons in 1972. The number of nonfatal accidents dropped from 478 in 1971 to 272 in 1972; however, the fatalities increased to 3 compared with 2 in the previous year.

DISTRIBUTION

Shipments of Pennsylvania anthracite reported for the coal year April 1, 1971, to March 31, 1972, totaled 7,841,827 net tons, a decrease of approximately 9% from the 1970–71 coal year. Of this amount, 83% was shipped to points within the United States, 5% to Canada, and 12% overseas. Compared with the 1970–71 coal year, shipments to American markets declined 7%; to Canada, 6%; and to foreign countries other than Canada, approximately 18%.

In the United States market, shipments of pea and larger sizes decreased by 12%; buckwheat No. 1, 18%; buckwheat No. 2 (rice), 7%; and buckwheat No. 3 (barley), 22%. However, the sizes not otherwise identified, increased 9%. In the Canadian market, pea and larger sizes dropped 18%, but the buckwheat No. 1 and smaller sizes, indicated a decline of only 2%. Exports to countries other than Canada, showed a decline in pea and larger, and buckwheat No. 1 and smaller sizes—14% and 26%, respectively.

All market areas in the United States indicated continued losses with the exception of the "Other States" category, which showed an increase of 6%. Shipments to the New England area were 15% below the 1970–71 coal year level; the Middle Atlantic area declined 6%; and the South Atlantic and Lake States dropped 23% and 27%, respectively.

CONSUMPTION AND USES

Apparent domestic consumption of anthracite in 1972 (production minus exports and shipments to U.S. Armed Forces, West Germany), was 5.9 million net tons, compared with 7.3 million tons in 1971. A diminishing market for space-heating anthracite and decreasing consumption at electric utilities contributed to the decline.

Overall consumption of anthracite was as follows: space-heating, 50%; electric utilities, 27%; and the remaining 23% divided among other industrial users. Although use data are incomplete for anthracite, declines occurred in all categories except coke-making, which indicated an increase of 13% over 1971.

The Federal Government continued to supplement the fuel needs of the U.S. Armed Forces in West Germany with purchases of anthracite. Shipments in 1972 were approximately 448,000 tons compared with 718,000 tons in 1971, a decrease of 38%.

STOCKS

Monthly data on stocks held in retail yards indicated an inventory of 123,000 tons, at yearend 1972, a decrease of 32.4% from January 1, 1972.

The electric utilities reported a decrease of 20.3% in their inventory—895,000 tons at yearend 1972, compared with yearend stocks of 1,123,000 tons in 1971.

Stocks at coke plants totaled 84,000 tons at the end of the year, a decrease of 28.8% from the beginning of the year.

Stocks at the Upper Lake docks (Lake Superior and Lake Michigan) dropped from 1,000 tons at yearend 1971 to less than 500 tons at yearend 1972.

PRICES AND SPECIFICATIONS

The average value of Pennsylvania anthracite production in 1972 was $12.00 per ton compared with $11.86 per ton in 1971. The slight increase was due to a greater demand for industrial sizes which have a lower market value. Total value of production in 1972 was $85,250,862, compared with $103,469,207 in 1971.

The average value per ton of the larger groups of sizes was $17.18 f.o.b. preparation plants, an increase of $0.79. Price increases per ton for these larger sizes—egg, stove, chestnut, pea—were $0.35, $1.08, $0.87, and $0.44, respectively. The average value per ton of the smaller sizes increased $0.24, to $10.14 per ton. The individual prices of smaller sizes were as follows: Buckwheat No. 1, $15.38 (increase of $0.55; buckwheat No. 2 (rice), $15.12 (increase of $0.56; buckwheat No. 3 (barley), $12.97 (increase of $0.41); buckwheat No. 4, $9.11 (increase of $1.04); buckwheat No. 5, $6.03 (decrease of $0.05); and other, $5.15 (increase of $0.71). All the above prices exclude dredge coal.

Average wholesale prices as quoted in the Black Diamond magazine were as follows: Egg and stove, $18.25 to $19.75; chestnut, $18.00 to $19.50; pea, $16.00 to $17.50; buckwheat No. 1, $16.00 to $17.50; buckwheat No. 2 (rice), $16.00 to $17.50; and buckwheat No. 3 (barley), $15.00 to $16.50.

FOREIGN TRADE

Data released by the Bureau of the Census, U.S. Department of Commerce, indicate that 743,451 net tons of Pennsylvania anthracite were exported in 1972, an increase of approximately 11% over 1971 exports. However, this does not fully reflect the movement of anthracite to the Continent, because the Bureau of Census does not include in its figures coal shipped abroad for the use of U.S. Armed Forces in West Germany. A more accurate measure of the export trade can be obtained, therefore, by adding the military tonnage to the Bureau of Census data. Shipments to the U.S. Armed Forces in 1972, totaled approximately 448,000 net tons as compared to the 718,000 net tons shipped in 1971, a decrease of approximately 38%.

Increased shipments to the European, Canadian, and South American markets were offset by decreased export tonnages to Asia and other countries—consequently, the net result was a decrease in total exports of anthracite in 1972 of approximately 198,000 net tons, or 14% below the 1971 level.

WORLD REVIEW

Precise data are not available from all anthracite producing countries. Some of the figures are only estimates while other countries include in their official data fuels which, by U.S. standards, are of no higher quality than semianthracite. Despite these inadequacies, information, when compared with data from similar sources for previous years, 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 of anthracite in 1972 (approximately 195.9 million short tons) showed a slight decrease of 1.4% from that in 1971.

Anthracite production generally reflects the demand. The ready availability of alternative and more convenient fuels at competitive prices is considered to be the principle reason for the lessening demand for anthracite in world fuel markets.

The People's Republic of China, North Korea, and the U.S.S.R. produced approximately 70% of the total world production, a slight increase of 3.5% over that in 1971. Preparation plants of the Ministry of the Coal Industry in the U.S.S.R. processed approximately 35,588,000 short tons of large and medium-size classification anthracite in 1972.

Imports of anthracite to Japan for 1972 totaled 833,000 short tons, compared with 1,746,000 tons for the same period in 1971. The People's Republic of China, South Korea, and Canada were principal sources, with total shipments of 585,000 short tons, or 70% of the total imported. Imports from North Vietnam continued to reflect the effects of the shipping blockade which reduced anthracite shipments to 74,000 short tons compared with 452,000 tons shipped to Japan in 1971. Until the suspension of shipments in May, 1972, Hongai coal accounted for most of Japan's imports of anthracite.

The Republic of South Africa's reduced demand and reversals in foreign trade contributed to the sharp drop in the production of anthracite in 1972. Output for the year totaled 1,473,000 short tons compared with 2,029,000 short tons in 1971. Of that total, 521,000 tons was consumed in the domestic market, and the remainder was exported to Japan and to Europe.

As the production of coal in Italy is minimal, there are no exports. Imports of anthracite from the United States increased from 229 short tons in 1971, to 32,000 tons in 1972. The U.S.S.R.'s trade in the first half of 1972 was characterized by sharply reduced anthracite deliveries to Italy which dropped from 95,000 tons in 1971, to 32,000 short tons in 1972.

Belgium's coal supply in 1972 was characterized by a drop in production and a sharp increase in consumption which required greater imports to close the gap between indigenous production and internal demand. The production of anthracite (up to 14% volatility), amounting to 3.3 million short tons, was almost 457,000 tons below the 1971 output. Belgium's exports in 1972 maintained the downward trend that characterized the trade in recent years. Virtually all of the export shipments went to member Community countries headed by West Germany.

TECHNOLOGY

The scientists and the engineers of the National Coal Board have developed a new unique process of obtaining active carbon from anthracite at a much cheaper rate.[2]

The new principle uses a fluidized bed steam activation process which utilizes the full advantage of anthracite's low-volatile content to obtain a higher yield of the final product than was previously possible with conventional activation processes.

Sized anthracite is fluidized with hot gas and then activated by injecting superheated steam into the reactor. While undergoing processing, the internal surface area of the carbon particles increased to approximately 30 times the untreated size. The active carbon is cooled, screened into different sizes and is then ready for collection for sale. Continuous control testing is carried on during manufacture to ensure that activity levels are maintained in the product to a consistently high standard.

One of the main uses of active carbon is in the treatment of potable water supplies for the removal of residual taste, odor, and color. In comparison to other filtration agents, active carbon is the best to absorb all those unwanted elements in water to make it safe for drinking purposes.

Anthracite has been used for several years for water filtration purposes but only in relatively small quantities as it was difficult to convert anthracite directly to active carbon.

Because of the sulfur limitations imposed by air-pollution-control regulations, the continuous availability of metallurgical-grade coking coals is becoming a matter of increasing concern to the iron and steel industry and other consumers of coke as other consuming sectors are using greater quantities of these low-sulfur coals in order to conform to the sulfur limitations. Anthracite, with its low sulfur content when combined with other chemical constituents used to produce foundry coke gives strength and stability to the coke. As a result, increasing quantities of anthracite may be used for the production of coke in the future.

Some fundamental research has been conducted by the Bureau to develop new uses for anthracite: Studies have been made of its mineral content and chemical constituents; experiments were conducted on its conversion to gas and its use in coke manufacture; and studies were made of the utilization of ash resulting from the combustion of anthracite. Such research is continuing at a modest level to improve anthracite utilization generally, including its use in industrial and commercial processes. Considering the present status of the industry, however, and the continuing decline in demand, the amount of research devoted to new uses, markets, and opportunities for anthracite is relatively limited.

The program initiated in 1962 by the Bureau to microfilm all available data relating to abandoned anthracite mines was continued during the year. Maps, cross sections, and other related data were recorded for future studies of subsidence, mine fire control, and for evaluating building sites. The data accumulated by the program also has proved to be an invaluable aid in evaluations made by the U.S. Army Corps of Engineers for maintenance and possible expansion of flood control projects under its jurisdiction in the northern anthracite field. The time available for project work in 1972 was severely limited because of work assignments resulting from the flood, particularly in map work related to subsidence, mine water, and levee studies. To date, a grand total of 9,046 mine and folio maps, comprising 24,435 frames, have been photographed.

[2] Dey, S. K. Higher Yield of Active Carbon From Anthracite Coal—A New Development by the NCB Scientists. The New Sketch, (Dhanbad, India), v. 33, No. 31, May 14, 1973, p. 30.

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.	Continuous.
Carbon County:			
Buck Mountain	Lime neutralization stream treatment.	Commonwealth of Pennsylvania.	Project completed 1972.
Lackawanna County:			
Jermyn Borough	Stream pollution abatement	do	Work in progress 1972.
Lackawanna, Susquehanna, Wayne Counties:			
Upper Lackawanna River.	Abatement and gravity discharge, design and specifications project.	do	Project completed 1972.
Do	Design including plans and specifications for gravity discharge.	do	Work in progress 1972.
Luzerne County:			
Catawissa Creek, Hazle Township.	Channel relocations to control acid water.	do	Do.
Jeddo Tunnel	Abatement of mine water and reclamation.	do	Do.
Sandy Run	Lime neutralization stream treatment plant.	do	Project completed 1972.
Wilkes-Barre Township.	Mine refuse bank	do	Work in progress 1972.
Do	Filling abandoned strip mine pits	do	Do.
Northumberland County:			
Shamokin Creek.	Engineering study to determine pollution abatement measures needed.	do	Project completed 1972.
Do	Stream restoration and operation of treatment plants.	do	Work in progress 1972.
Schuylkill County:			
Catawissa Creek	Plugging of abandoned Audenried Tunnel.	do	Cancelled temporarily.
Frailey Township	Installation of flumes and drainage ditches, sealing strip pits, and reconditioning of stream beds of Bailey and Gebhard Runs. Completed upper and lower beds.	do	Work in progress 1972.
Hegins Township	Rehabilitation of surface area of Rausch Creek and Lorberry Creek watershed.	do	Project completed 1972.
Rausch Creek	Lime neutralization mine discharge treatment plant.	do	Work in progress 1972.
Swatara Creek	Survey of Swatara Creek watershed to evaluate abatement measures needed on Panther and Black Creeks.	do	Project completed 1972.
Do	Survey to evaluate abatement measures needed on Middle and Goodspring Creeks, and Gebhard and Coal Runs.	do	Do.
Do	Survey to determine pollution abatement measures needed on Lower Rausch Creek and Lorberry Creek.	do	Do.
SURFACE SUBSIDENCE			
Lackawanna County:			
Scranton, Green Ridge.	Demonstration project for hydraulic backfill of mine voids under approximately 35 acres of Green Ridge section of Scranton. Blind flushing technique used.	Commonwealth of Pennsylvania and U.S. Bureau of Mines.	Work started and in progress during 1972.
UNDERGROUND MINE FIRES			
Columbia County:			
Centralia Borough	Appalachia mine fire control, which includes Phase I exploratory drilling and Phase II (1) underground barrier pillars formed by injecting fly ash into mine void of West barrier, Phase II (2) underground barrier pillars formed by injecting fly ash into mine void east barrier.	do	Phase I completed 1968; Phase II work in progress 1972.
Lackawanna County:			
Carbondale Township	Appalachia mine fire control at site of former mine in the southwest part of the city of Carbondale, which includes Phase I exploratory drilling, Phase II excavation of isolation trench, and sand seal barrier backfill.	do	Phase I completed 1969; Phase II completed in 1972.

Table 3.—Project report—Continued

Project location	Project description	Sponsor	Status of report
	UNDERGROUND MINE FIRES—Continued		
Luzerne County:			
Hazleton Borough	Appalachia mine fire control at site of former Hill mine property, which includes Phase I exploratory drilling and Phase II seal blocking with sand and total fire excavation.	Commonwealth of Pennsylvania and U.S. Bureau of Mines.	Phase I completed 1969; Phase II work in progress 1972.
Laurel Run Borough	Appalachia mine fire control, which included Phase I exploratory, Phase II (1) sealing 3 tunnels, Phase II (2) reinforcing East and West barriers with sand seals, Phase II (3) additional sand barrier seals.	do	All Phases completed, except Phase II (3) in progress 1972.
Swoyersville Borough, Kingston Township.	Appalachia mine fire control at site of former Forty Fort Mine property, which includes Phase I exploratory drilling and Phase II excavation.	do	Do.
Warrior Run Borough	Appalachia mine fire control at site. Phase I includes exploratory drilling to determine extent of fire.	do	Work started in 1971; still in progress 1972.
Schuylkill County:			
Shenandoah Borough	Appalachia mine fire control at site of former Kehley Run Colliery, Phase I exploratory drilling only; control work taken over by the Commonwealth of Pa. in 1970.	do	Phase I work completed in 1968.

Table 4.—Summary of monthly developments in the Pennsylvania anthracite industry in 1972

(Thousand short tons, except as otherwise indicated)

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year 1972	Change from 1971 (%)	Year 1971
Production (including mine fuel, local sales, and dredge coal)	583	542	622	487	706	515	465	688	611	682	650	555	7,106	−18.6	8,727
Shipments (breakers and washeries only, all sizes):															
By rail [1]	150	166	205	180	298	257	212	303	288	282	255	199	2,795	−19.7	3,482
By truck [2]	356	403	439	299	318	230	216	304	301	384	380	336	3,966	−11.6	4,487
Carloadings [3]	3	3	4	4	5	4	3	5	5	5	5	3	49	−18.3	60
Distribution:															
Lake Erie loadings [4]	3	--	3	2	6	3	3	2	5	5	5	2	39	−23.5	51
Upper Lake dock trade: [5]															
Receipts	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	1	−50.0	2
Deliveries (reloadings)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	2	−71.4	7
Exports [7]	29	64	26	25	77	87	31	49	141	52	121	41	743	+10.7	671
Industrial consumption and stocks by:															
Electric utilities: [8]															
Consumption	157	155	145	140	156	130	100	119	116	111	116	139	1,584	−3.8	1,646
Stocks	1,088	1,033	1,017	1,000	975	904	856	886	867	903	928	895	895	−20.3	1,123
Coke plants:															
Used for carbonizing	40	42	42	38	37	41	36	37	38	40	41	42	474	+5.1	451
Stocks	107	125	79	68	66	61	60	68	70	90	96	84	84	−28.8	118
Stocks on Upper Lake docks: [5]															
Lake Superior	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lake Michigan	1	1	(6)	(6)	1	1	1	1	1	(6)	(6)	(6)	(6)	--	1
Stocks in retail dealer yards: [9]															
Chestnut and larger	95	79	69	69	80	99	100	97	100	80	80	73	73	−27.0	100
Pea	7	7	6	6	7	8	9	8	8	7	7	7	7	−36.4	11
Buckwheat No. 1 and rice	50	42	37	39	51	59	54	51	53	45	47	43	43	−39.4	71
Total	152	128	112	114	138	166	163	156	161	132	134	123	123	−32.4	182
Retail dealer deliveries: [9]															
Chestnut and larger	92	96	58	34	27	16	18	27	33	77	55	58	591	−30.0	844
Pea	17	18	20	7	4	9	7	15	11	41	15	16	180	−46.1	334
Buckwheat No. 1 and rice	50	51	43	23	20	16	17	29	30	40	34	48	401	−9.5	443
Total	159	165	121	64	51	41	42	71	74	158	104	122	1,172	−27.7	1,621
Wholesale price indexes (1957–59 = 100): [10]															
F.o.b. car at mines:															
Chestnut	134.9	134.9	134.9	134.9	134.9	134.9	134.9	138.6	146.1	146.1	146.1	146.1	136.4	+1.5	134.4
Buckwheat No. 1	161.9	161.9	161.9	161.9	161.9	161.9	161.9	166.4	176.5	176.5	176.5	176.5	163.8	+2.1	160.4

[1] Furnished by initial carriers.
[2] Pennsylvania Department of Environmental Resources.
[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, 697,092 short tons of anthracite were exported to Europe during 1972 compared with 904,948 short tons for 1971. Of this total 464,680 short tons were consigned to West Germany and the Netherlands including exports to the U.S. military forces. This compares with 748,996 short tons for 1971.

Table 5.—Commercial production of Pennsylvania anthracite in 1972, by region and size

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 [2]	Rail	Truck	Total [2]	Rail	Truck	Total [2]
Quantity, thousand short tons:																		
Lump and broken	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Egg	38	2	40	9	1	10	21	1	22	69	3	72	--	--	--	69	3	72
Stove	152	31	183	214	152	366	99	81	180	464	265	730	--	--	--	464	265	730
Chestnut	70	109	179	107	258	365	55	153	208	232	520	752	--	--	--	232	520	752
Pea	36	107	143	47	201	248	17	155	172	100	463	563	--	--	--	100	463	563
Total pea and larger [2]	296	250	546	377	612	989	192	390	582	865	1,251	2,117	--	--	--	865	1,251	2,117
Buckwheat No. 1	113	91	204	91	232	323	42	175	217	246	498	744	--	--	--	246	498	744
Buckwheat No. 2 (rice)	16	137	153	32	284	316	18	113	131	66	534	600	--	--	--	66	534	600
Buckwheat No. 3 (barley)	70	84	154	127	312	439	43	110	153	240	506	746	--	--	--	240	506	746
Buckwheat No. 4	54	46	100	220	150	370	39	20	58	313	216	528	--	3	3	313	219	531
Buckwheat No. 5	202	175	377	547	243	791	29	4	34	778	422	1,202	--	12	12	778	434	1,214
Other [3]	--	157	157	70	299	369	23	131	154	93	587	680	306	156	462	399	743	1,142
Total buckwheat No. 1 and smaller [2]	455	690	1,145	1,087	1,521	2,608	194	554	747	1,736	2,765	4,501	306	171	477	2,042	2,936	4,978
Grand total [2]	751	940	1,691	1,464	2,133	3,597	386	944	1,330	2,601	4,017	6,618	306	171	477	2,906	4,188	7,095
Value, thousands:																		
Lump and broken	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Egg	$702	$28	$730	$159	$15	$174	$393	$12	$405	$1,254	$55	$1,309	--	--	--	$1,254	$55	$1,309
Stove	2,680	552	3,232	3,765	2,666	6,431	1,825	1,445	3,270	8,270	4,663	12,933	--	--	--	8,270	4,663	12,933
Chestnut	1,223	1,902	3,125	1,839	4,447	6,286	1,023	2,849	3,872	4,085	9,198	13,283	--	--	--	4,085	9,198	13,283
Pea	550	1,686	2,236	741	3,060	3,801	278	2,544	2,822	1,569	7,290	8,859	--	--	--	1,569	7,290	8,859
Total pea and larger [2]	5,155	4,168	9,323	6,504	10,188	16,692	3,519	6,850	10,369	15,178	21,206	36,384	--	--	--	15,178	21,206	36,384
Buckwheat No. 1	1,747	1,380	3,127	1,355	3,443	4,798	674	2,856	3,530	3,774	7,679	11,454	--	--	--	3,774	7,679	11,454
Buckwheat No. 2 (rice)	240	2,059	2,299	483	4,249	4,732	275	1,768	2,043	998	8,076	9,074	--	--	--	998	8,076	9,074

Buckwheat No. 3 (barley)	995	1,132	2,126	1,488	3,939	5,427	593	1,522	2,115	3,076	6,593	9,669	--	--	--	3,076	6,593	9,669
Buckwheat No. 4	493	391	884	2,262	1,124	3,386	372	180	552	3,127	1,695	4,822	--	13	13	3,127	1,708	4,835
Buckwheat No. 5	1,445	922	2,368	3,110	1,401	4,511	213	31	244	4,768	2,354	7,123	--	46	46	4,768	2,400	7,169
Other [3]	--	757	757	299	1,434	1,733	115	902	1,017	414	3,093	3,507	2,263	722	2,985	2,677	3,815	6,492
Total buckwheat No. 1 and smaller [2]	4,921	6,641	11,562	8,997	15,590	24,587	2,242	7,259	9,501	16,160	29,490	45,651	2,263	781	3,044	18,423	30,270	48,695
Grand total [2]	10,076	10,809	20,885	15,501	25,778	41,279	5,761	14,109	19,870	31,338	50,696	82,035	2,263	781	3,044	33,602	51,477	85,079
Average value per ton: [4]																		
Lump and broken	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Egg	$18.35	$17.54	$18.32	$16.67	$15.75	$16.58	$18.47	$18.29	$18.46	$18.16	$17.15	$18.11	--	--	--	$18.16	$17.15	$18.11
Stove	17.69	17.56	17.67	17.61	17.49	17.56	18.46	17.73	18.13	17.82	17.57	17.73	--	--	--	17.82	17.57	17.73
Chestnut	17.37	17.39	17.39	17.26	17.22	17.23	18.58	18.65	18.63	17.61	17.68	17.66	--	--	--	17.61	17.68	17.66
Pea	15.23	15.72	15.60	15.75	15.24	15.33	16.11	16.42	16.38	15.62	15.74	15.72	--	--	--	15.62	15.74	15.72
Total pea and larger	17.40	16.70	17.08	17.25	16.64	16.87	18.29	17.57	17.81	17.53	16.94	17.18	--	--	--	17.53	16.94	17.18
Buckwheat No. 1	15.39	15.17	15.29	14.93	14.82	14.85	16.01	16.29	16.23	15.33	15.40	15.38	--	--	--	15.33	15.40	15.38
Buckwheat No. 2 (rice)	15.50	15.01	15.06	15.00	14.94	14.95	15.48	15.62	15.60	15.25	15.10	15.12	--	--	--	15.25	15.10	15.12
Buckwheat No. 3 (barley)	14.22	13.49	13.82	11.73	12.62	12.36	13.96	13.87	13.87	12.84	13.04	12.97	--	--	--	12.84	13.04	12.97
Buckwheat No. 4	9.18	8.41	8.82	10.26	7.49	9.15	9.63	8.93	9.39	10.01	7.82	9.11	--	4.06	4.06	10.01	7.77	9.08
Buckwheat No. 5	7.27	5.78	6.90	5.69	5.75	5.71	7.21	7.23	7.22	6.13	5.78	6.08	--	3.70	3.70	6.13	5.70	6.00
Other [3]	5.94	4.89	4.96	4.26	4.80	4.70	5.00	6.88	6.60	4.70	5.23	5.15	7.41	4.64	6.47	6.68	5.12	5.63
Total buckwheat No. 1 and smaller	10.82	9.62	10.09	8.28	10.25	9.43	11.57	13.11	12.71	9.31	10.66	10.14	7.41	6.38	6.38	9.57	10.31	9.78
Grand total	13.41	11.50	12.35	10.59	12.08	11.48	14.92	14.95	14.94	12.05	12.62	12.40	7.41	6.38	6.38	11.56	12.29	11.99

[1] Includes Sullivan County.
[2] Data may not add to totals shown because of independent rounding.
[3] Includes various mixtures of buckwheat Nos. 2 to 5 and coal of relatively low dollar value.
[4] Average value derived from actual, rather than rounded data.

Table 6.—Sizes of Pennsylvania anthracite (excluding dredge coal) prepared at plants, by region

(Percent)

State	Lehigh region					Schuylkill region				
	1968	1969	1970	1971	1972	1968	1969	1970	1971	1972
Lump [1] and broken	--	--	--	--	--	--	--	--	--	--
Egg	4.5	4.6	4.0	4.6	2.4	1.2	1.2	1.0	0.9	0.3
Stove	10.3	10.0	9.4	10.9	10.8	9.4	9.8	10.7	10.4	10.2
Chestnut	12.0	13.1	11.1	11.0	10.6	11.1	11.3	12.3	10.7	10.1
Pea	10.9	10.7	9.2	9.9	8.5	7.7	7.4	8.3	7.4	6.9
Total pea and larger	37.7	38.4	33.7	36.4	32.3	29.4	29.7	32.3	29.4	27.5
Buckwheat No. 1	11.0	11.7	10.2	10.6	12.1	11.0	11.2	11.0	10.2	9.0
Buckwheat No. 2 (rice)	9.6	11.2	9.4	10.7	9.0	9.5	9.2	9.8	8.9	8.8
Buckwheat No. 3 (barley)	10.3	10.8	11.9	10.1	9.1	11.8	14.5	13.1	12.7	12.2
Buckwheat No. 4	6.6	8.0	7.2	5.6	5.9	6.5	7.0	6.8	9.6	10.3
Buckwheat No. 5	16.9	16.9	14.7	12.1	14.5	13.0	13.2	13.5	20.4	22.0
Other [2]	7.9	3.0	12.9	14.5	17.1	18.8	15.2	13.5	8.8	10.2
Total buckwheat No. 1 and smaller	62.3	61.6	66.3	63.6	67.7	70.6	70.3	67.7	70.6	72.5
	Wyoming region					Total				
Lump [1] and broken	(3)	--	--	(3)	--	(3)	--	--	(3)	--
Egg	1.9	3.1	2.4	1.9	1.7	2.2	2.5	2.1	2.1	1.1
Stove	11.7	12.0	10.3	13.0	13.6	10.2	10.4	10.3	11.1	11.0
Chestnut	15.6	15.9	15.5	12.7	15.6	12.5	12.8	12.7	11.2	11.4
Pea	12.2	12.2	11.5	12.7	12.9	9.7	9.4	9.3	9.2	8.5
Total pea and larger	41.4	43.2	39.7	40.3	43.8	34.6	35.1	34.4	33.6	32.0
Buckwheat No. 1	14.4	14.7	15.4	17.1	16.4	11.9	12.2	11.8	11.8	11.2
Buckwheat No. 2 (rice)	9.2	9.4	8.7	8.8	9.8	9.4	9.7	9.4	9.3	9.1
Buckwheat No 3 (barley)	10.3	9.7	10.7	11.0	11.5	11.1	12.4	12.2	11.6	11.3
Buckwheat No. 4	2.6	3.6	5.3	4.3	4.4	5.5	6.4	6.6	7.4	8.0
Buckwheat No. 5	5.1	2.6	4.5	3.4	2.5	11.8	11.6	11.8	14.6	16.1
Other [2]	17.0	16.8	15.7	15.1	11.6	15.7	12.6	13.8	11.7	12.3
Total buckwheat No. 1 and smaller	58.6	56.8	60.3	59.7	56.2	65.4	64.9	65.6	66.4	68.0

[1] Quantity of lump included is insignificant.
[2] Includes various mixtures of buckwheat Nos. 2 to 5 and coal of relatively low dollar value.
[3] Less than 0.05%.

Table 7.—Production of Pennsylvania anthracite in 1972, 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 [2]	Quantity	Value [2]
REGIONS								
Lehigh:								
Preparation plants	751	10,076	940	10,809	3	49	1,694	20,934
Schuylkill:								
Preparation plants	1,464	15,501	2,133	25,778	5	65	3,601	41,345
Dredges	306	2,263	171	781	--	--	477	3,044
Total Schuylkill [1]	1,770	17,764	2,304	26,559	5	65	4,078	44,389
Wyoming:								
Preparation plants [3]	386	5,761	944	14,109	3	57	1,334	19,928
Total: [1]								
Preparation plants	2,601	31,338	4,017	50,696	11	171	6,629	82,206
Dredges	306	2,263	171	781	--	--	477	3,044
Grand total [1]	2,906	33,602	4,188	51,477	11	171	7,106	85,251
COUNTIES								
Berks, Lancaster, Snyder	305	2,263	159	735	--	--	464	2,998
Carbon	140	1,856	43	186	--	--	183	2,042
Columbia	77	1,260	20	214	--	--	98	1,475
Dauphin	--	--	52	435	--	--	52	435
Lackawanna	51	707	260	4,120	--	--	311	4,827
Luzerne	832	11,921	1,258	16,544	6	102	2,097	28,567
Northumberland	343	2,734	566	6,610	--	--	908	9,345
Schuylkill	1,158	12,860	1,761	22,051	5	69	2,925	34,980
Sullivan	--	--	68	582	--	--	68	582
Total [1]	2,906	33,602	4,188	51,477	11	171	7,106	85,251

[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.

Table 8.—Pennsylvania anthracite produced, by field
(Thousand short tons)

Field	1968	1969	1970	1971	1972
Eastern Middle: Breakers and washeries	1,559	1,583	1,511	1,519	1,221
Western Middle:					
Breakers and washeries	2,840	2,806	2,540	2,167	1,741
Dredges	17	5	W	W	W
Total	2,857	2,811	W	W	W
Southern:					
Breakers and washeries	3,557	3,183	3,183	2,849	2,333
Dredges	589	530	W	W	W
Total	4,146	3,713	W	W	W
Northern: Breakers and washeries [1]	2,899	2,366	2,086	1,802	1,334
Total:					
Breakers and washeries	10,855	9,938	9,320	8,337	6,629
Dredges	606	535	409	390	477
Grand total	11,461	10,473	9,729	8,727	7,106

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

Table 9.—Pennsylvania anthracite produced in 1972, 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	--	--	--	802	419	--	1,221
Western Middle	23	102	125	698	919	W	W
Southern	276	247	523	1,123	687	W	W
Northern [2]	295	1	296	860	177	--	--
Total	594	350	944	3,483	2,202	477	7,106
REGION							
Lehigh	--	5	5	1,075	614	--	1,694
Schuylkill	299	344	643	1,548	1,411	477	4,078
Wyoming	295	1	296	860	177	--	1,334
Total	594	350	944	3,483	2,202	477	7,106

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.

Table 10.—Production of Pennsylvania anthracite from strip pits

	Mined by stripping (thousand short tons)	% of fresh-mined total	Number of men employed	Average number of days worked
1968	4,696	65.7	1,891	239
1969	4,579	68.5	1,787	256
1970	4,541	72.3	1,855	234
1971	4,478	77.7	1,800	273
1972:				
Lehigh region	1,075	24.3	488	266
Schuylkill region	1,548	35.0	846	249
Wyoming region [1]	860	19.4	677	271
Total or average	3,483	78.7	p 2,011	p 261

p Preliminary.
[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	1970				1971				1972			
	Number of front-loaders	Number of power shovels	Number of draglines	Total	Number of front-loaders	Number of power shovels	Number of draglines	Total	Number of front-loaders	Number of power shovels	Number of draglines	Total
Gasoline	--	4	2	6	--	1	2	3	--	--	1	1
Electric	--	18	40	58	--	18	36	54	--	19	42	61
Diesel	--	72	104	176	77	43	85	205	103	41	75	219
Diesel-electric	--	--	--	--	--	--	1	1	--	--	--	--
Total	--	94	146	240	77	62	124	263	103	60	118	281

Table 12.—Production of Pennsylvania anthracite from culm banks, by region

(Thousand short tons)

Year	Lehigh region	Schuylkill region	Wyoming region	Total [1]
1968	958	1,868	883	3,709
1969	775	1,815	662	3,253
1970	921	1,591	524	3,036
1971	729	1,544	300	2,573
1972	614	1,411	177	2,202

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

Table 13.—Estimated production of Pennsylvania anthracite in 1972, by week [1]

Week ended—	Thousand short tons	Week ended—	Thousand short tons	Week ended—	Thousand short tons
Jan. 8	103	May 13	157	Sep. 16	118
15	167	20	172	23	182
22	128	27	133	30	152
29	155	Jun. 3	145	Oct. 7	162
Feb. 5	155	10	147	14	167
12	115	17	143	21	175
19	124	24	109	28	136
26	115	Jul. 1	51	Nov. 4	148
Mar. 4	183	8	38	11	163
11	98	15	76	18	171
18	124	22	151	25	113
25	159	29	164	Dec. 2	152
Apr. 1	131	Aug. 5	140	9	164
8	122	12	132	16	115
15	84	19	157	23	110
22	117	26	170	30	110
29	154	Sep. 2	165		
May 6	175	9	109	Total	7,106

[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.

Table 14.—Estimated monthly production of Pennsylvania anthracite [1]

(Thousand short tons)

Month	1968	1969	1970	1971	1972
January	965	973	808	725	583
February	962	911	770	654	542
March	960	898	814	780	622
April	926	916	759	795	487
May	986	869	763	782	706
June	824	812	809	740	515
July	853	704	707	620	465
August	1,016	877	898	813	688
September	953	947	880	767	611
October	1,136	985	895	710	682
November	994	831	815	685	650
December	886	750	811	656	555
Total	11,461	10,473	9,729	8,727	7,106

[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 [1] and pit-car loaders		Total [2] loaded mechanically	
	Number of units	Quantity loaded	Number of units	Quantity loaded	Number of units	Quantity loaded	Number of units	Quantity loaded
1968	131	710	26	121	184	643	341	1,475
1969	106	567	25	190	158	570	289	1,327
1970	103	491	20	183	147	476	270	1,151
1971	95	319	18	151	91	199	204	670
1972	81	347	16	136	46	111	143	594

[1] Includes duckbills and other self-loading conveyors.
[2] Data may not add to totals shown because of independent rounding.

Table 16.—Trends in mechanical loading,[1] hand loading, and stripping of Pennsylvania anthracite

(Thousand short tons)

Year	Fresh-mined coal							
	Underground					Strip pits		Total
	Mechanical loading	% of total underground	Hand loading	% of total underground	Total	Quantity	% of fresh mined coal	
1968	1,475	60.2	975	39.8	2,450	4,696	65.7	7,146
1969	1,327	63.0	779	37.0	2,106	4,579	68.5	6,685
1970	1,151	66.1	591	33.9	1,742	4,541	72.3	6,283
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

[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	Lehigh region					Schuylkill region				
	1968	1969	1970	1971	1972	1968	1969	1970	1971	1972
Lump [1] and broken	--	--	--	--	--	--	--	--	$6.00	--
Egg	$12.99	$14.16	$14.90	$17.59	$18.32	$13.26	$13.66	$14.27	16.83	$16.58
Stove	12.93	14.05	14.98	16.62	17.67	12.82	13.92	15.35	16.65	17.56
Chestnut	12.93	14.08	15.19	16.47	17.39	12.66	13.84	15.29	16.58	17.23
Pea	10.33	11.75	13.56	14.60	15.60	10.44	11.91	13.46	15.00	15.33
Total pea and larger	12.18	13.43	14.65	16.14	17.08	12.15	13.38	14.81	16.21	16.87
Buckwheat No. 1	9.70	11.18	12.78	14.55	15.29	10.03	11.56	13.26	14.77	14.85
Buckwheat No. 2 (rice)	10.24	11.49	12.94	14.33	15.06	9.80	11.30	12.99	14.45	14.95
Buckwheat No. 3 (barley)	8.29	9.42	11.07	12.71	13.82	8.13	9.54	11.05	12.30	12.36
Buckwheat No. 4	5.72	5.92	7.16	8.51	8.82	5.91	6.67	7.60	8.00	9.15
Buckwheat No. 5	5.54	5.80	6.20	6.64	6.28	4.95	5.34	5.54	5.88	5.71
Other [2]	3.36	3.55	4.14	4.04	4.81	3.56	3.73	3.68	3.50	4.70
Total buckwheat No. 1 and smaller	7.20	8.39	8.51	9.78	10.09	6.65	7.76	8.77	9.39	9.43
Total all sizes	9.08	10.33	10.74	12.10	12.35	8.26	9.43	10.72	11.40	11.48
	Wyoming region [3]					Total				
Lump [1] and broken	$14.80	--	--	--	--	$14.80	--	--	$6.00	--
Egg	13.24	$13.86	$15.62	$19.29	$18.46	13.12	$13.95	$14.93	17.76	$18.11
Stove	13.40	14.32	16.00	16.67	18.13	13.02	14.06	15.41	16.65	17.73
Chestnut	13.58	14.58	16.75	17.56	18.63	13.02	14.12	15.67	16.79	17.66
Pea	11.61	12.81	14.83	16.30	16.38	10.80	12.14	13.87	15.28	15.72
Total pea and larger	12.93	13.96	15.93	16.96	17.81	12.40	13.56	15.06	16.39	17.18
Buckwheat No. 1	10.56	11.77	13.62	15.15	16.23	10.13	11.53	13.26	14.83	15.38
Buckwheat No. 2 (rice)	10.59	11.79	13.77	15.17	15.60	10.11	11.47	13.14	14.56	15.12
Buckwheat No. 3 (barley)	8.26	9.43	11.07	13.13	13.87	8.20	9.49	11.06	12.56	12.97
Buckwheat No. 4	5.80	7.55	7.16	7.78	9.39	5.84	6.56	7.40	8.07	9.11
Buckwheat No. 5	4.17	4.65	4.41	6.61	7.22	5.06	5.47	5.65	6.08	5.93
Other [2]	2.45	1.98	4.50	6.24	6.60	3.22	3.16	4.00	4.44	5.16
Total buckwheat No. 1 and smaller	7.04	7.88	9.56	11.50	12.71	6.87	7.93	8.92	9.90	10.14
Total all sizes	9.48	10.51	12.09	13.70	14.94	8.78	9.91	11.03	12.08	12.40

[1] Quantity 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 short ton)

Region	1971 Shipped by rail	1971 Shipped by truck	1971 Colliery fuel	1971 Total	1972 Shipped by rail	1972 Shipped by truck	1972 Colliery fuel	1972 Total
Lehigh	$13.48	$10.88	$15.27	$12.11	$13.41	$11.50	$15.61	$12.35
Schuylkill	10.65	11.34	14.16	11.04	10.04	11.52	14.36	10.88
Wyoming [2]	14.15	13.47	14.08	13.70	14.92	14.95	15.94	14.94
Total	12.00	11.74	14.59	11.86	11.56	12.29	15.21	12.00

[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 1972, by size [1]

(Per short ton)

Size	Winter	Spring	Summer-fall	End of year
Egg and Stove	$18.25	$18.75	$19.90–$19.75	$19.90–$19.75
Chestnut	18.00	18.50	19.50	19.50
Pea	$16.00–16.10	16.50	17.50	17.50
Buckwheat No. 1	16.00–16.10	16.50	17.50	17.50
Buckwheat No. 2 (rice)	16.00–16.10	16.50	17.50	17.50
Buckwheat No. 3 (barley)	15.00	15.50	16.50	16.50

[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 1972

	Lehigh region	Schuylkill region	Wyoming region [1]	Total 1972 p	Total 1971
Average number of men working daily:					
Underground	24	384	242	650	1,440
In strip pits	488	846	677	2,011	1,800
At culm banks	132	151	31	314	540
At preparation plants	357	744	370	1,471	1,500
Other surface	68	162	57	287	460
Total excluding dredge operations	1,069	2,287	1,377	4,733	5,740
Dredge operations	NA	NA	NA	50	60
Total	1,069	2,287	1,377	4,783	5,800
Average number of days active:					
All operations except dredges	NA	NA	NA	215	238
Dredge operations	NA	NA	NA	300	300
Average, all operations	NA	NA	NA	216	239
Man-days of labor:					
All operations except dredges	NA	NA	NA	1,018,000	1,366,000
Dredge operations	NA	NA	NA	15,000	18,000
Total, all operations	NA	NA	NA	1,033,000	1,384,000
Average tons per man-day:					
All operations except dredges	NA	NA	NA	6.51	6.10
Dredge operations	NA	NA	NA	31.79	21.64
Average, all operations	NA	NA	NA	6.88	6.30

p Preliminary. NA Not available.
[1] Includes Sullivan County.

Table 21.—Distribution of Pennsylvania anthracite, April 1, 1971, to March 31, 1972, by State, province and country of destination, in net tons

Destination	Pea and larger					Buckwheat No. 1 and smaller					Total all sizes
	Broken and egg	Stove	Chestnut	Pea	Total	Buck-wheat No. 1	Buck-wheat No. 2 (rice)	Buck-wheat No. 3 (barley)	Other	Total	
United States:											
New England States:											
Connecticut	--	2,929	4,923	252	8,104	1,005	604	43	328	1,980	10,084
Maine	--	3,638	3,761	--	7,399	387	2,240	--	257	2,884	10,283
Massachusetts	398	14,978	11,468	1,314	28,158	2,612	5,510	1	8,670	16,793	44,951
New Hampshire	--	2,432	2,403	30	4,865	851	1,105	--	100	2,056	6,921
Rhode Island	--	415	643	--	1,058	43	--	--	12	55	1,113
Vermont	--	4,700	3,716	808	9,224	1,101	5,455	--	--	6,556	15,780
Total	398	29,092	26,914	2,404	58,808	5,999	14,914	44	9,367	30,324	89,132
Middle Atlantic States:											
New Jersey	632	23,678	59,473	12,030	95,813	17,309	6,617	5,639	140,866	170,431	266,244
New York	6,342	147,947	91,611	221,133	467,033	109,095	42,859	64,432	258,348	474,734	941,767
Pennsylvania [1]	13,484	198,254	508,535	389,651	1,109,924	537,696	618,884	660,391	1,394,720	3,211,691	4,321,615
Total	20,458	369,879	659,619	622,814	1,672,770	664,100	668,360	730,462	1,793,934	3,856,856	5,529,626
South Atlantic States: [2]											
Delaware	965	5,071	6,645	2,190	14,871	1,208	137	2,493	33	3,871	18,742
Dist. of Columbia	--	994	1,312	321	2,627	487	448	209	685	1,829	4,456
Maryland	--	16,630	10,062	3,615	30,307	2,678	6,972	15,866	14,397	39,913	70,220
Virginia	--	1,776	666	188	2,630	58	267	54	5,678	6,057	8,687
Total	965	24,471	18,685	6,314	50,435	4,431	7,824	18,622	20,793	51,670	102,105

Lake States:											
Illinois	142	99	532	76	849	24,856	7,030	203	12,302	44,391	45,240
Indiana	--	175	1,937	10,099	12,211	98	261	334	37,127	37,820	50,031
Michigan	164	50,903	5,616	137	56,820	30	349	22	29,483	29,884	86,704
Minnesota	--	35	6	5	46	6	2	5	11,148	11,161	11,207
Ohio	--	32,731	1,853	9,158	43,742	29,113	7,379	324	74,477	111,293	155,035
Wisconsin	--	1,687	636	151	2,474	41	257	56	4,347	4,701	7,175
Total	306	85,630	10,580	19,626	116,142	54,144	15,278	944	168,884	239,250	355,392
Other States	485	36	1,470	19,018	21,009	71,937	1,653	20,490	333,626	427,706	448,715
Total United States	22,612	509,108	717,268	670,176	1,919,164	800,611	708,029	770,562	2,326,604	4,605,806	6,524,970
Canada:											
Ontario	3,031	36,650	27,186	2,904	69,771	24,302	9,425	4,625	27,080	65,432	135,203
Quebec	243	3,026	2,556	1,568	7,393	17,339	27,613	111,451	100,923	257,326	264,719
Other Provinces	--	830	957	4,016	5,803	8,786	361	1	3,389	12,537	18,340
Total Canada	3,274	40,506	30,699	8,488	82,967	50,427	37,399	116,077	131,392	335,295	418,262
Other countries	135,369	346,803	143,958	22,954	649,084	6,834	3,578	55,689	183,410	249,511	898,595
Grand total	161,255	896,417	891,925	701,618	2,651,215	857,872	749,006	942,328	2,641,406	5,190,612	7,841,827

[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 1972, by month, and by State of destination [1]

(Thousand short tons)

Destination	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	% of total trucked
Pennsylvania:														
Within region	161	182	210	115	132	69	55	116	124	149	145	126	1,584	39.9
Outside region	153	167	176	145	146	117	118	137	129	170	173	162	1,793	45.2
New York	26	37	39	33	31	34	37	43	37	43	48	33	441	11.1
New Jersey	10	11	9	4	7	6	4	4	5	9	9	11	89	2.2
Delaware	2	1	1	1	(2)	1	1	2	1	2	1	2	15	.4
Maryland	3	3	3	1	2	2	1	1	1	2	2	2	23	.6
District of Columbia	--	(2)	--	--	--	--	--	--	--	--	--	--	(2)	--
Other States	1	1	1	(2)	(2)	1	(2)	1	4	9	2	1	21	.6
Total:[3] 1972	356	403	439	299	318	230	216	304	301	384	380	336	3,966	100.0
1971	432	377	337	362	334	341	330	391	361	392	408	424	4,487	100.0

[1] Compiled from reports of Pennsylvania Department of Environmental Resources; 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	1968	1969	1970	1971	1972
TRUCK SHIPMENTS					
Pennsylvania:					
Within region	2,021	1,918	1,847	1,880	1,584
Outside region	2,269	2,151	1,979	2,050	1,793
New York	409	369	418	373	441
New Jersey	248	247	198	126	89
Delaware	26	22	18	17	15
Maryland	188	94	50	29	23
District of Columbia	2	2	2	(2)	(2)
Other States	18	17	15	12	21
Total [3]	5,181	4,821	4,527	4,487	3,966
RAIL SHIPMENTS					
New England States	163	107	102	100	49
New York	606	645	455	532	281
New Jersey	263	291	173	113	85
Pennsylvania	846	940	847	819	830
Delaware	1	(2)	1	1	5
Maryland	32	34	19	24	2
District of Columbia	9	4	7	3	3
Virginia	6	6	9	7	3
Ohio	98	215	151	122	124
Indiana	43	70	66	54	42
Illinois	108	102	93	57	47
Wisconsin	14	6	12	8	10
Missouri	--	--	--	--	30
Minnesota	13	25	51	1	10
Iowa	--	--	--	--	31
Michigan	42	33	53	70	49
Other States	233	312	408	455	290
Total United States [3]	2,476	2,792	2,447	2,366	1,891
Canada	308	373	384	411	386
Other countries	697	853	691	572	374
Grand total [3]	3,481	4,018	3,522	3,347	2,651

[1] Compiled from reports of Pennsylvania Department of Environmental Resources; does not include dredge coal.
[2] Less than ½ unit.
[3] Data may not add to totals shown because of independent rounding.

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: Coke making	Iron and steel industry: Sintering and pelletizing 2	Other uses e	Unaccounted for 3
1968	4,759	56	2,203	181	532	748	1,635	46
1969	4,209	17	1,849	213	543	623	1,355	--
1970	4,042	16	1,897	W	472	464	1,357	--
1971	3,850	15	1,646	W	r 421	339	1,037	--
1972	2,960	11	1,584	W	474	283	603	--

e Estimate. r Revised. W Withheld to avoid disclosing individual company confidential data; included in "Other uses."
1 Federal Power Commission.
2 American Iron and Steel Institute, Annual Statistical Report.
3 Data discontinued after December 1969.

Table 25.—U.S. exports of anthracite by country and customs district

	1971 Short tons	1971 Value (thousands)	1972 Short tons	1972 Value (thousands)
COUNTRY				
Argentina	4,006	$138	2,721	$68
Australia	3,976	237	1,477	90
Brazil	3,947	327	3,496	237
Canada	466,039	6,018	500,306	6,641
Chile	905	36	4,288	81
Colombia	358	19	893	70
Finland	320	14	--	--
France	101,330	1,473	154,918	2,291
Germany, West	26,248	440	--	--
India	278	17	55	1
Iran	954	58	55	5
Italy	229	3	32,463	499
Japan	10,543	103	--	--
Korea, Republic of	190	2	--	--
Mexico	4,316	115	6,903	184
Netherlands	1,469	76	8	1
Philippines	1,042	45	662	29
Singapore	4,149	120	--	--
Surinam	254	19	263	17
Sweden	46	1	9,240	146
United Kingdom	22	2	--	--
Venezuela	2,967	97	13,894	345
Vietnam, South	2,713	41	--	--
Yugoslavia	33,891	678	10,987	198
Other	832	25	822	19
Total	671,024	10,104	743,451	10,922
CUSTOMS DISTRICT				
Baltimore	54,410	602	748	37
Buffalo	108,612	1,725	115,669	1,838
Cleveland	--	--	17,772	369
Detroit	1,033	13	5,675	83
Galveston	618	8	--	--
Houston	11,077	610	1,091	56
Laredo	4,316	115	6,903	184
Los Angeles	135	2	--	--
Miami	26	1	--	--
Mobile	--	--	10	(1)
New Orleans	3,438	231	3,486	236
New York City	1,006	29	1,343	44
Norfolk	155	2	4,856	78
Ogdensburg	45,265	764	33,216	590
Pembina	30	2	695	20
Philadelphia	440,619	5,996	551,987	7,387
Portland, Oregon	229	3	--	--
San Francisco	55	1	--	--
Total	671,024	10,104	743,451	10,922

1 Less than ½ unit.
NOTE: According to the Association of American Railroads, 697,092 short tons of anthracite were exported to Europe during 1972 compared with 904,948 short tons during 1971. Of this total 464,680 short tons were consigned to West Germany and the Netherlands including exports to the U.S. Armed Forces. This compares with 748,996 short tons during 1971.

Table 26.—Anthracite: [1] World production by country

(Thousand short tons)

Country [2]	1970	1971	1972 p
Belgium	4,063	3,715	3,258
Bulgaria	177	176	e 176
China, People's Republic of e	22,000	22,000	22,000
France	10,850	10,118	e 10,700
Germany, West	11,261	10,935	8,235
Ireland	r 88	30	e 33
Japan	1,145	549	504
Korea, North	24,000	26,800	30,100
Korea, Republic of	13,662	14,093	13,672
Morocco	477	524	603
Netherlands	5,011	4,183	e 3,650
Peru	22	e 22	e 22
Portugal	299	279	278
Romania e	r 16	r 16	16
South Africa, Republic of	1,850	2,029	1,473
Spain	3,095	3,170	3,312
U.S.S.R	83,558	83,511	e 84,900
United Kingdom	4,061	4,476	3,695
United States (Pennsylvania)	9,729	8,727	7,106
Vietnam, North e	3,300	3,300	2,200
Total	198,664	198,653	195,933

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 reported and available information is inadequate to make reliable estimates; in Colombia output may total 100,000 tons annually, while in New Zealand and South Vietnam, output is insignificant.

Cobalt

By John D. Corrick [1]

Cobalt consumption increased 13% in 1972 compared with that of 1971; this was the first increase in consumption since 1969. Demand for cobalt at the beginning of 1972 was depressed; however, a progressive improvement in demand occurred during the second half of 1972. Consumer stocks, which had reached their lowest level in 5 years during 1971, remained at a low, but relatively stable, level during 1972. Government sales of cobalt from the strategic stockpile were a significant source of supply during 1972 with over 8.6 million pounds sold.

Legislation and Government Programs.—General Services Administration (GSA) continued to offer specification-grade and subspecification-grade (Calera material) cobalt metal in various forms for sale during 1972. Sales were on an unrestricted-bid basis except that total sales of specification-grade material were limited to approximately 1 million pounds per month and 500,000 pounds per bidder per month. Government sales of cobalt for the year totaled 8,629,692 pounds, compared with 901,699 pounds sold in 1971. Of the quantity sold, 5,015,061 pounds was subspecification Calera cobalt, GSA's entire Calera stock.

As of December 13, 1972, total U.S. Government stockpile inventory was 71,499,318 pounds of cobalt. Of this quantity, 67,913,260 pounds was stockpile grade.

Table 1.—Salient cobalt statistics

(Thousand pounds of contained cobalt)

	1968	1969	1970	1971	1972
United States:					
Consumption	12,998	15,608	13,367	12,500	14,130
Imports for consumption	9,068	12,911	12,417	10,912	13,915
Stocks, Dec. 31: Consumer	2,139	2,191	1,890	1,411	1,193
Price: Metal, per pound	$1.85	$1.85–$2.20	$2.20	$2.20–$2.45	$2.45
World: Production, mine	41,968	43,556	52,590	47,908	51,290

DOMESTIC PRODUCTION

Domestic production of cobalt-bearing pyrite concentrates was discontinued at the end of 1971, shutting off the only source of domestically mined cobalt. Professional Oil and Management Co. (POM Corp.) and The Hanna Mining Co. agreed to explore and possibly develop the Iron Creek copper-cobalt prospect located in the Salmon-Blackbird mining district of Idaho. The prospect was owned by POM's subsidiary, Sachem Prospects Corp.[2] At yearend, the company had driven 615 feet of underground openings, built 500 feet of bulldozer roads, and taken approximately 1,000 feet of core samples.

American Metals Climax Inc. (AMAX), through a new division, AMAX Nickel, continued rehabilitation of its Port Nickel, La., refinery. Late in 1972 the company acquired additional acreage which doubled the amount previously owned and increased river frontage from 1,800 to 3,600 feet.[3] Tentatively the refinery will begin processing material from the Botswana Bamangwato Concessions nickel-copper project in 1974. In addition to nickel, the refinery will produce cobalt from other feed materials acquired by AMAX.

[1] Physical scientist, Division of Ferrous Metals.
[2] Mining Journal. Copper-Cobalt Project in the United States. V. 178, No. 7129, Apr. 7, 1972, p. 281.
[3] Skillings' Mining Review. AMAX Buys More Port Nickel, La., Property. V. 61, No. 47, Nov. 11, 1972, p. 10.

CONSUMPTION AND USES

Consumption of cobalt in the United States in 1972 was 13% above that in 1971 and reversed a declining trend that began in 1970. Increased consumption could be related to improved economic activity around the world, particularly the demand for cobalt in superalloys and magnetic alloys. Major uses of cobalt in 1972, as shown in table 4, were in magnetic alloys, superalloys, salts and driers, and cutting and wear-resistant materials. Data reported by consumers showed that of the cobalt consumed in the United States during 1972, 74% was as metal, 19% was as salts and driers, 5% was as oxide, and 1% was as purchased scrap. Total U.S. cobalt consumption was 14.1 million pounds in 1972.

Officials of Varian Associates announced commercial production of samarium-cobalt magnets through the use of powder metallurgy techniques. The magnets were to be produced in the form of rings, rods, bars, rectangles, and sections for use in microwave tubes, electric watches, motors and generators, solid state devices, and instruments. Researchers at Varian investigated other rare-earth cobalt alloys which showed even greater promise than samarium-cobalt. Among those alloys tested were praseodymium-cobalt and misch-metal cobalt.[4]

Numerous new cobalt alloys were introduced in 1972. E. I. du Pont de Nemours & Co., Inc. introduced a novel group of patented, high-temperature cobalt-based alloys with superior wear and friction resistance.[5] These intermetallic materials were designed for high-temperature applications where lubrication was a problem. The alloys were composed of cobalt, molybdenum, and silicon and were available in powder form for plasma spray applications and hard surfacing, and as irregularly shaped powders for powder metallurgy usage. The Huntington Alloy Products Division of the International Nickel Co. (INCO) introduced a new nickel-based heat-resisting alloy containing 12.5% cobalt and designated Inconel 617.[6] The alloy was developed for use in gas turbines exposed to high temperatures and was reported to have excellent resistance to oxidation and carburization at 1,095°C.

[4] American Metal Market. High Energy Magnets Set. V. 79, No. 100, May 26, 1972, p. 9.
[5] American Metal Market. Wear-Resistant Cobalt Alloys for Lubrication on Market. V. 79, No. 233, Dec. 6, 1972, p. 17.
[6] American Metal Market. Variety of Lab Developments Listed for Cobalt Materials. V. 79, No. 138, July 27, 1972, p. 12.

Table 2.—Cobalt materials consumed by refiners or processors in the United States

(Thousand pounds of contained cobalt)

Form [1]	1968	1969	1970	1971	1972
Alloy and concentrate	1,184	516	274	356	333
Metal	1,831	2,819	2,639	2,899	3,063
Hydrate	14	25	32	18	16
Other	11	1	9	9	16

[1] Total consumption is not shown because some metal and hydrate originated from alloy and concentrate, and a total would involve duplication.

Table 3.—Cobalt products [1] produced and shipped by refiners and processors in the United States

(Thousand pounds)

	1971				1972			
	Production		Shipments		Production		Shipments	
	Gross weight	Cobalt content	Gross weight	Cobalt content	Gross weight	Cobalt content	Gross weight	Cobalt content
Oxide	713	489	771	519	651	459	824	581
Hydrate	523	322	483	296	830	513	788	487
Salts [2]	6,306	1,681	6,240	1,679	5,354	1,336	5,382	1,361
Driers	8,335	728	8,580	769	9,623	834	9,771	843
Total	15,877	3,220	16,074	3,263	16,458	3,142	16,765	3,272

[1] Figures on metal withheld to avoid disclosing individual company confidential data.
[2] 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	1972
Steel:	
Carbon	3
Stainless and heat-resisting	39
Full alloy	217
High-strength low-alloy	7
Electric	W
Tool	361
Cast irons	W
Superalloys	3,012
Alloys (exclude alloy steels and superalloys):	
Cutting and wear-resistant materials [1]	1,273
Welding and alloy hard-facing rods and materials	199
Magnetic alloys	3,441
Nonferrous alloys	651
Other alloys	676
Mill products made from metal powder	W
Chemical and ceramic uses:	
Pigments	165
Catalysts	702
Ground coat frit	144
Glass decolorizer	61
Other	173
Miscellaneous and unspecified	315
Total	11,439
Salts and driers: Lacquers, varnishes, paints, ink, pigments, enamels, glazes, feed, electroplating, etc.	e 2,691
Grand total	14,130

e Estimate. 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	1968	1969	1970	1971	1972
Metal	10,456	12,057	10,056	9,006	10,509
Oxide	573	646	626	625	733
Purchased scrap	143	328	69	125	197
Salts and driers	1,826	2,577	2,616	2,744	2,691
Total	12,998	15,608	13,367	12,500	14,130

PRICES

The producer price for cobalt metal in the form of granules (shot) or broken cathodes in 551-pound (250-kilogram) drums remained at $2.45 per pound, f.o.b. New York or Chicago, throughout the year.

Sales of cobalt metal by the Government on a "sealed-bid" basis ranged in price from $2.15 to $2.41 per pound for specification-grade material and from $1.92 to $2.15 per pound for subspecification-grade material. 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 2,148,261 pounds, gross weight, having a value of $3,168,899, and went to 17 countries. Japan and West Germany received the greater part, 1,164,710 pounds ($1,358,131) and 550,933 pounds ($1,115,547), respectively. Exports of wrought cobalt metal and alloys, 448,844 pounds, gross weight, having a value of $1,836,158, went to 19 countries. The imports of cobalt salts and compounds given in table 7 came principally from France and the United Kingdom.

Table 6.—U.S. imports for consumption of cobalt metal and oxide, by country

(Thousand pounds and thousand dollars)

Country	Metal				Oxide			
	1971		1972		1971		1972	
	Gross weight	Value	Gross weight	Value	Gross weight	Value	Gross weight	Value
Belgium-Luxembourg	r 2,499	r 5,973	3,344	8,242	726	1,425	878	1,913
Canada	909	1,933	633	1,540	--	--	221	342
Finland	1,208	2,696	1,299	3,189	--	--	--	--
France	126	180	500	1,035	--	--	--	--
Germany, West	2	4	12	25	--	--	(1)	1
Japan	--	--	45	118	--	--	--	--
Netherlands	42	76	49	67	--	--	--	--
Norway	800	1,758	915	2,083	--	--	--	--
United Kingdom	223	212	131	142	(1)	1	(1)	(1)
Zaire	4,572	r 9,545	5,083	11,602	--	--	35	74
Zambia	--	--	1,071	2,607	--	--	--	--
Total	10,381	r 22,377	13,082	30,650	726	1,426	1,134	2,330

r Revised.
1 Less than ½ unit.

Table 7.—U.S. imports for consumption of cobalt, by class

(Thousand pounds and thousand dollars)

Year	Metal		Oxide		Salts and compounds		Total	
	Gross weight	Value	Gross weight	Value	Gross weight	Value	Gross weight	Cobalt content e
1970	11,873	26,020	710	1,394	157	92	12,740	12,417
1971	10,381	r 22,377	726	1,426	40	27	11,147	10,912
1972	13,082	30,650	1,134	2,330	82	44	14,298	13,915

e Estimate. r Revised.

WORLD REVIEW

Cobalt produced in the free world in 1972 was sufficient to meet demand. Zaire led all countries in mine production of cobalt and accounted for 56% of the total world output. Nevertheless, cobalt metal production decreased in Zaire, Zambia, Canada, West Germany, and Finland in 1972 compared with that of 1971. Reasons for decreased production were varied and ranged from Zaire's reducing production in order to bring the supply-demand relationship into better balance to West Germany's difficulties in securing adequate supplies of raw materials.

Australia.—Construction work began in 1972 on the Freeport Minerals Co. Greenvale nickel-cobalt project in Queensland, Australia. The Greenvale project was a 50–50 joint venture between Metals Exploration N.L. and Freeport Minerals Co. Freeport, which held a 22% equity interest in Metals Exploration, holds a total interest of approximately 61% in the project. The Ralph M. Parsons Co. of the United States was contracted to design and construct processing facilities at Townsville, Australia, to treat the Greenvale laterite ore. The plant will treat annually approximately 2.3 million tons of dry ore and produce about 46 million pounds of nickel and 2.75 million pounds of cobalt in the form of nickel-cobalt sulfide. A group of five Japanese companies reportedly will purchase all of the nickel-cobalt sulfide produced for the life of the mine. Production was scheduled for 1974.

Canada.—Mine production of cobalt decreased in 1972 by 4% compared with that of 1971. INCO's deliveries of cobalt were 2,210,000 pounds in 1972, compared with 1,980,000 pounds in 1971 and 1,870,000 pounds in 1970. Cobalt production at the Falconbridge Nickel Mines Ltd. refinery in Kristiansand, Norway, was halted when a fire in May killed three workers and seriously damaged the refinery. Inventories of refined cobalt were exhausted early in 1972. Reportedly, Falconbridge's new refinery in Norway was to begin producing cobalt in March 1973. A newly formed European subsidiary of Falconbridge, Falconbridge Europe S.A., took over the

Table 8.—Cobalt: World production by country
(Short tons)

Country	Mine output, cobalt content [1]			Metal [2]		
	1970	1971	1972 p	1970	1971	1972 p
Australia	517	343	e 815	--	--	--
Canada [3]	2,281	2,162	2,076	1,419	1,204	e 1,030
Cuba e	1,700	1,700	1,700	--	--	--
Finland e	1,400	1,400	1,400	1,111	1,020	885
France [4]	--	--	--	r 335	635	e 660
Germany, West [4]	--	--	--	911	662	504
Morocco	666	1,078	1,261	--	--	--
Norway	NA	NA	NA	[5] 862	[5] 958	[5] e 1,000
U.S.S.R.[6]	1,700	1,750	1,800	1,700	1,750	1,800
United States	W	W	W	162	154	--
Zaire	15,386	13,228	e 14,330	14,742	16,003	14,377
Zambia [7]	2,645	2,293	2,263	2,262	2,292	e 2,090
Total	r 26,295	23,954	25,645	r 23,504	24,678	22,346

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

[1] In addition to the countries listed, Bulgaria, Cyprus, East Germany, New Caledonia, Norway, Poland, Spain and Sweden are known to produce ores (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] The United Kingdom recovers cobalt metal from intermediate metallurgical products imported from Canada, but data on output is 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, which import substantial quantities of crude materials containing cobalt, have not recorded output in recent years, but may be producing metal and/or cobalt compounds. Poland apparently processes cobalt-bearing copper ores but no data on cobalt recovery are available.

[3] Actual mine output not reported. Data presented for mine output are total cobalt content of all products, including nickel oxide sinter shipped to United Kingdom and nickel-copper matte shipped to Norway for further processing. Data presented for metal content 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 reduced to metal as well as total metal actually recovered in Canada and the United Kingdom.

[4] Domestic mine output, if any, is negligible.

[5] Produced entirely from nickel-copper matte imported from Canada; domestic mine output is recovered abroad.

[6] Insufficient data are available to permit separate estimates of mine and metal production.

[7] Metal figures given are content of matte.

sale of cobalt and nickel in Belgium, the Netherlands, and Spain from Brandeis Goldschmidt in 1972. Falconbridge continued to make progress on the construction of the Becancour, Quebec, refinery complex. When completed in 1975, the refinery will produce 500,000 pounds per year of high-purity cobalt salts. Sherritt Gordon Mines Ltd. reportedly had a refinery output of cobalt in 1972 of 809,000 pounds compared with 561,000 pounds in 1971. Sales of cobalt for the 2 years were 713,000 and 679,000 pounds, respectively. Officials of Sherritt Gordon reported the successful completion of tests at its Fort Saskatchewan demonstration plant on laterite ore from Gag Island, Indonesia for P. T. Pacific Nickel Indonesia in 1972. A detailed feasibility study on mining and processing facilities to produce over 100 million pounds of nickel and approximately 4 million pounds of cobalt per year was to be completed in the fourth quarter of 1972. Officials of Dickerson Mines of Canada reported the shutdown of its cobalt refining operation in February 1972. The refinery reportedly had problems obtaining raw materials during its 10 years of operation. The company's inventory of cobalt, silver, gold, and copper at the refinery was liquidated early in 1971.

Finland.—Officials of Outokumpu Oy reported continued progress on the development of the Vuonos mine. Concentration of nickel ore from the Vuonos mine began in late 1971. When in full operation the mine will produce 72,000 tons per year of cobalt-rich iron pyrites. Cobalt metal production was 885 tons in 1972, compared with 1,020 tons in 1971.

India.—Recent discoveries of nickel-cobalt ore bodies in the State of Orissa prompted the National Metallurgical Laboratory at Jamshedpur to develop a suitable process for treating serpentinous and lateritic nickeliferous ores. The process involved a roast-reduction step followed by ammoniacal leaching. Commercial feasibility of the developed process would require a nickel recovery of 60% from an ore containing over 0.41% nickel. The Sukinda nickel deposit in Orissa was estimated to contain 14 million tons of nickel laterite ore grading 0.8 to 1.4% nickel.

Indonesia.—P. T. Pacific Nickel Indonesia received a favorable report from tests performed at Sherritt Gordon's Fort Saskatchewan plant on laterite ore from Gag Island. Detailed feasibility studies on mining and processing facilities were to be completed in late 1972 by Sherritt Gordon for P. T. Pacific, in which Sherritt had a 10% interest.

Officials of INCO reported signing participation and sales agreements with six Japanese firms covering its nickel project on the Indonesian island of Sulawesi. INCO's subsidiary, P. T. International Nickel Indonesia, was to control 60% with the remaining 40% divided evenly between Japanese firms and Indonesians. Initial production capacity was rated at over 15,000 tons of nickel plus cobalt per year in the form of a 75% nickel matte.

Philippines.—Despite devastating floods which took a heavy toll of life and property in the Philippines in 1972, work progressed satisfactorily on construction of Marinduque Mining and Industrial Corp.'s nickel refinery on Nonoc Island. Bechtel Corp. and Bechtel Overseas Corp. were providing engineering, procurement, and construction management services for the project. When completed in July 1974, the project will produce 3.3 million pounds of cobalt per year in the form of mixed sulfides along with nickel briquets and powder. Overseas Private Investment Corp. pledged to guarantee $17 million in U.S. loans for the $232.5 million project. The value of U.S. equipment and services for the project was estimated at over $60 million. By mid–1972, Marinduque had placed a $1.9 million order with Sumitomo Shipbuilding and Machinery Co. for eight electrostatic precipitators and four dust collectors. Sumitomo was licensed by Joy Manufacturing Co. of the United States to build Joy-designed dust collectors for Asian markets. Delivery of equipment was slated for spring 1973. At yearend, officials of Marinduque announced a $3 million sale of stock, thereby completing its $8 million equity share of the $232.5 million project. Sherritt Gordon was to buy $6.8 million of Marinduque stock, an increase of $1.8 million over the original amount Sherritt agreed to buy.

Sumitomo Metal Mining Co., Ltd., Nippon Mining Co., Ltd., Pacific Metals Co., and Nissho-Iwai Co. of Japan continued negotiating with Soriano Co. of the Philippines for development of nickel-cobalt deposits on Palawan Island. The ore was offered the consortium by Rio Tuba Nickel Mining Corp. of the Philippines. The Japanese were requested to finance 80% of the project's cost. If negotiations succeed, it was estimated that 1 million tons of ore per year would be mined beginning about 1976.

Uganda.—Reduced mine production by Kilembe Copper Cobalt Ltd. in 1972 could be traced to labor unrest resulting from expulsion of technicians by the Government and uncertain copper markets. Kilembe reportedly was "down to the bone" staff-wise. The company requested the Ugandan Government to grant tax reliefs, which if not granted would decrease exploration work and thereby reduce reserves. Probable ore reserves did decrease by about 1.1 million tons in 1971 with little additional probable ore outlined. A cobalt bearing pyrite concentrate was produced and stockpiled at the mine during 1972.

Zaire.—La Générale des Carrières et Mines du Zaïre (GECAMINES), the state holding company for all extractive metallurgy activities in Zaire, through its operating company La Générale Congolaise des Minerais (GÉCOMIN) was again the leading world producer of cobalt, accounting for 56% of the total world mine output. Cobalt production came from the Province of Shaba, formerly known as Kinshasa. Principal producing mines were the western group, comprised of the underground Kamoto and the open pits of Kamoto, Musonoi, and Ruwe; and the central group, comprised of the underground Kambove and the open pits of Sesa and Kakanda. The Luilu refinery treated ore from the western group of mines, while the Shituru plant treated ore from the central group of mines. A new mill at the Musonoi mine began trial operations in mid-July and became operational in October.

As a result of depressed world cobalt markets in 1971, about 3,500 tons of cobalt had been stockpiled by yearend 1971. New ore reserves in Shaba were reported by officials of GECAMINES as 32.4 million tons containing 190,948 tons of recoverable cobalt and 852,212 tons of recoverable copper.

Japanese interests and the Government of Zaire were negotiating for the construction of approximately 550 miles of rail line to fill gaps in the present rail system and provide an unbroken line from Shaba to the Atlantic Ocean, a distance of 1,240 miles. Ore shipments in Zaire presently must travel a complicated route of jungle river boats and primitive rail lines, taking from 30 to 40 days to reach the Atlantic coast. The new rail lines would cut shipping time to approximately 3 days. Decreased shipping time reportedly would allow the quantity of exported ore to be increased from 500,000 tons per year to about 800,000 tons per year by 1980.

Société Minière de Tenke-Fungurume, in which Standard Oil Co. (Indiana) held a 28% interest, completed 220 test boreholes representing 25,126 meters of diamond drilling in the Tenke-Fungurume district of Zaire. Assays on material from 168 of these holes delineated probable and indicated ore reserves of 20 million tons grading 6.2% copper and 0.4% cobalt. Inferred reserves were estimated at 14.8 million tons.

Zambia.—Nchanga Consolidated Copper Mines Ltd. (NCCM) began installation of commercial-scale carbon columns at its Rokana cobalt plant in 1972. The company was prompted to install the columns after successfully operating pilot-sized columns for 2 years. The pilot columns were capable of removing up to 80% of the contained sulfur with a resulting increase in capacity of 2%.

Roan Consolidated Mines Ltd. (RCM) planned on doubling output of its Chambishi mine by initiating underground operations. RCM awarded a $40 million contract to the British firm of Balfour Bealty and Co. to conduct the necessary civil and mechanical engineering and construction work at Chambishi. The contract will involve extensions to metallurgical buildings, installation of ore crushing and flotation equipment, head frame and hoisting equipment, rail extensions, and construction of permanent living quarters for workers.

Zambia's two mining companies, NCCM and RCM, approved capital expenditures of $663 million during 1972–76 for maintaining and expanding current production of copper and cobalt. These expenditures fall under Zambia's second 5-year national development plan. At yearend, Zambia was successful in lining up loans from foreign countries to cover part of the expenditures. The Government, acting through the state-run Mining and Industrial Development Corp., was setting up a new central committee to supervise the nationalization of the copper-cobalt industry. The stated objectives of centralization were to achieve the optimum rate of nationalization, to rationalize training activities, and to develop industry manpower plans.

TECHNOLOGY

Bureau of Mines scientists reported the use of a cobalt-molybdate catalyst to remove over 90% of the nitrogen and sulfur compounds from shale oil. The catalyst was used in the initial hydrogenation step of a process to convert oil shale to gasoline having an octane rating of 89. The researchers found that a pressure of 200 pounds per square inch and a temperature of 900°F were preferred if optimum amounts of gasoline were to be produced.

Interest was maintained during the year on the development of high-strength magnets formed by alloying cobalt with various rare-earth metals. Scientists from General Electric Co. successfully increased the maximum energy product of the company's rare earth-cobalt permanent magnets by 10% to 25 million gauss-oersteds.[7] Bureau of Mines' scientists continued their investigations into the properties of praseodymium-cobalt magnets during 1972. Researchers at Tohoku University in Japan demonstrated that ductile permanent magnets composed of iron, chromium, cobalt, and molybdenum exhibited a maximum energy product of 5 million gauss-oersteds after appropriate heat treatment. The discovery was significant in that the lower cost ductile alloy's energy product was exceeded only by that of the more expensive cobalt-platinum magnets.[8]

General Magnaplate Corp. of Linden, N.J., announced the development of a

[7] Work cited in footnote 6.
[8] Work cited in footnote 6.

coating process whereby nickel and cobalt metals were electroplated to the surfaces of powdered metal parts. The new technique reportedly gave gears a tough, nonporous surface with permanent lubricity and abrasion and corrosion resistance under severe temperature, atmospheric, and load conditions.[9]

The State University of New York reported development of an antithrombogenic cobalt-chromium alloy. The alloy, in the form of tubes and valves, was tested as cardiovascular implants in dogs. Because of the alloy's resistance to corrosion in biological fluids, it was reported to have great potential in cardiovascular prostheses.[10]

Numerous technological innovations were reported in the formation of cobalt alloys in 1972. General Electric Co. was granted a U.S. patent covering a high-temperature, oxidation- and corrosion-resisting cobalt-based alloy having improved strength and ductility. The new alloy (FSX-430) was claimed to have greater high-temperature ductility, creep-rupture strength, and oxidation resistance while maintaining the high-temperature tensile strength and hot corrosion resistance of its predecessors.[11] INCO developed a cast heat-resistant nickel-base alloy (IN-643) containing 12% cobalt for use over extended periods under high stress and at temperatures up to 1,150°C.

A large number of patents were issued both in the United States and abroad, ranging from extractive metallurgy through smelting technology to the formation of new cobalt alloys. Technical papers were presented on unalloyed and alloyed cobalt systems, heat-resisting alloys, magnetic materials, tool and wear-resisting materials, cast irons and alloy systems, films and coatings, nonmetallic uses of cobalt, and analytical techniques.[12]

---

[9] American Metal Market. Nickel-Cobalt Plating Is Key to Improved P/M Components. V. 79, No. 170, Sept. 18, 1972, p. 37.

[10] Work cited in footnote 6.

[11] Work cited in footnote 6.

[12] Cobalt—Quarterly Publication on Cobalt and Its Uses. (Cobalt Information Center, Battelle Mem. Inst., Columbus, Ohio). Nos. 54-57, March-December 1972.

Coke and Coal Chemicals

By Eugene T. Sheridan [1]

Production of coal coke in the United States in 1972 was about 5% greater than in 1971. The increased output was attributed partially to the fact that coke plants operated continuously throughout the year whereas, in 1971, operations were curtailed by labor strikes in both the steel and bituminous coal industries. Part of the increase was the result of greater demand for coke by blast furnaces, which increased their output of pig iron and ferroalloys in 1972 by nearly 10%.

Production, which averaged 5.0 million tons per month, remained relatively stable throughout the year. The average output per day for all plants ranged from a low of 155,000 tons in January to a high of 172,000 tons in April, with daily output for the year averaging 165,000 tons.

Demand for coke exceeded production during most of the year and producers month-end stocks of oven coke were 16% lower at the end of the year than when the year began. Stocks on hand at oven-coke plants at the end of 1972 were equivalent to 18 days' production at the December rate of output.

Blast furnaces continued to use the bulk of the Nation's coke production, receiving 92% of the 61.1 million tons of coke distributed by producers. However, consumption of coke per ton of hot metal produced at blast furnaces decreased, because of a significant increase in the quantities of fuel oil, tar, and pitch used as supplemental fuels in blast furnaces.

Breeze production increased 5%, mainly because more coal was carbonized. Breeze is unsuitable for most metallurgical applications because of its small size and high ash content, the larger part of the breeze production is used by producers for sintering iron ores and other industrial purposes. However, 50% of the 1972 output was sold, mainly for use as a reductant in electric furnaces that smelt phosphate rock to produce elemental phosphorus. Sales of breeze in 1972 were 13% greater than in 1971.

Coal costs increased substantially in 1972. The average delivered value of coking coals carbonized at oven-coke plants increased $1.73 per ton, while the value of coking coals carbonized at beehive plants increased $1.31 per ton. Price increases were reported by plants in all States except Minnesota and Wisconsin; the largest increases were noted for the coals received by plants in Kentucky, Missouri, Tennessee, and Texas.

Production of coke-oven gas increased 6% because of a higher yield and because more coal was carbonized. Output of ammonia, crude tar, and crude light oil increased also, for the same reasons.

Coke prices increased again during 1972. The average value of $40.70 per ton received by producers for all grades of oven coke and $22.04 per ton for all grades of beehive coke represented respective price increases of 9% and 3%. The average value of blast-furnace coke remained at about the level of 1971. The unit value of foundry and other industrial coke, however, increased 7% and 24%, respectively.

Foreign trade in coke was relatively small; exports amounted to only about 2% of the production. The bulk of the coke exported was shipped to Canada, West Germany, Mexico, the Netherlands, and Spain. Exports declined 18% from the 1971 level.

The total value of all coals carbonized was $1,374 million, and the total value of all products of carbonization was $2,375 million. The combined value of coke and breeze, the principal products, accounted for 88% of the total value of all products.

---

[1] Supervisory mineral specialist, Division of Fossil Fuels—Mineral Supply.

Table 1.—Salient coke statistics

	1968	1969	1970	1971	1972
United States:					
Production:					
Oven coke----thousand short tons--	62,878	64,047	65,654	56,664	59,853
Beehive coke-------------do----	775	710	871	772	654
Total-------------------do----	63,653	64,757	66,525	57,436	60,507
Exports---------------------do----	792	1,629	2,478	1,509	1,232
Imports---------------------do----	94	173	153	174	185
Producers' stocks, Dec. 31--------do----	5,985	3,120	4,113	3,510	2,941
Consumption, apparent----------do----	62,438	66,166	63,207	56,689	60,029
Value of coal-chemical materials used or sold--------------------thousands--	$281,250	$288,963	$293,464	$260,171	$295,656
Value of coke and breeze used or sold thousands--	1,187,402	1,402,716	1,899,116	1,848,781	2,080,072
Total value of all products used or sold [1] thousands--	1,468,651	1,691,679	2,192,580	2,108,953	2,375,728
World production:					
Hard coke---------thousand short tons--	348,112	370,205	386,308	372,979	374,593
Gashouse and low-temperature coke thousand short tons--	31,293	30,738	28,415	24,688	22,927

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

COKE AND BREEZE

DOMESTIC PRODUCTION

Recovering from the effects of labor strikes that curtailed production during the latter part of 1971, production assumed more normal levels during 1972 and output for the year was 5% greater than in 1971. Monthly production varied between 4.7 million and 5.3 million tons, with the largest output recorded in May. Daily output for the year averaged 165,000 tons, up 5% from the 157,000 tons per day recorded during 1971. These data are shown in table 5.

Ninety-one percent of the oven coke in 1972 was produced at furnace plants. These are plants that are owned by, or financially affiliated with, iron and steel companies and are operated mainly to produce coke for use in their blast furnaces. The remaining oven coke was produced by merchant plants, which is the segment of the industry that produces various grades of coke for sale on the open market. There were 48 furnace plants and 14 merchant plants in operation throughout the year. Current annual and monthly outputs of these plants are shown in tables 6 and 7.

Coke was produced in 18 States in 1972. The relative amounts of coke produced in the various States have changed little in the past decade, except that Connecticut and Massachusetts have ceased to be producing States and production was discontinued in New Jersey in 1971. Because coke is used principally for blast furnace fuel, the coke industry is concentrated in the major steel-producing areas of the Eastern and North Central States. The bulk of the 1972 coke output was produced in 14 States east of the Mississippi River. About 4 million tons, 7% of the total, was produced in States west of the Mississippi River.

Pennsylvania, the largest producer, accounted for 27% of the output and was followed by Indiana, Ohio, Alabama, and Michigan, in the order named. The combined output of these five States was nearly three-fourths of the national total. These data are shown in table 8.

An average of 1,476 pounds of coke was produced for each ton of coal carbonized in the United States in 1972. The 1972 yield of coke from coal, which averaged 68.96% has remained fairly constant during the past decade.

Breeze is the term applied to the small sizes of coke that result from screening. Although there is no designated size, breeze refers generally to coke that passes through a 1/2-inch screen. Coke producers currently consume 53% of the breeze produced, principally as a fuel in agglomerating plants. The remainder is sold, mainly for use as a fuel for smelting phosphate rock to produce elemental phosphorus. The amount of breeze sold has increased significantly in recent years and in 1972, nearly, 50% of the quantity produced was sold.

The breeze yield varies according to operating practices and the quality of the coals carbonized. The lowest yield, 3.4%, was recorded for Pennsylvania, while the yield for Indiana averaged 6.5%. The national average yield of 4.9% in 1972 has not varied significantly during the past decade.

An average of 98.4 pounds of breeze was produced for each ton of coal carbonized at oven-coke plants in 1972. Breeze yields of beehive-coke plants were substantially higher than those of oven plants, but beehive breeze production was negligible because only a few plants had recovery facilities.

Production and disposal of breeze, by State, in 1972 are shown in table 9. Table 10 shows the quantities consumed by producers for various uses and the quantities sold during the past 5 years.

CONSUMPTION AND SALES

Consumption of coke in the United States in 1972 totaled 60 million tons. This quantity (domestic production plus imports, minus exports and changes in stocks) was about 3 million tons more than that consumed in 1971 and the increase was attributed principally to greater demand for blast-furnace coke, caused by a 8-million-ton increase in blast-furnace pig iron and ferroalloy production. Apparent consumption of coke in the United States in 1972, including a breakdown for that used in iron furnaces and for all other purposes, is shown in table 11.

The decline in blast-furnace coke consumption rates between 1968 and 1972 is shown in table 12. Except for slight increases in 1965 and 1970, the coke rate has declined each year during the past decade. The amount of coke required to produce 1 ton of pig iron and ferroalloys in blast furnaces in 1972 was only 1,222 pounds, compared with 1,351 pounds in 1963. The net effect of this 10% reduction in coke consumption rates over the 10-year period can best be emphasized by noting that if the 1972 output of 89.4 million tons of blast-furnace pig iron and ferroalloys had been produced in blast furnaces operating at the 1963 rate, total blast-furnace coke requirements for the year would have been 60 million tons, rather than the 55 million tons actually consumed.

Although a variety of operating practices affect blast-furnace coke rates, the pronounced reduction in the 1972 coke rate resulted mainly from a 67% increase in the quantities of fuel oil, tar, and pitch consumed over those used in 1971. The 289 million gallons of fuel oil and 64 million gallons of tar and pitch used as supplemental fuels in blast furnaces in 1972 were equivalent in calorific value to that contained in about 2 million tons of coke.

Tables 13 and 14 show the quantities of coke used and sold in each State in 1972. A total of 61 million tons of oven and beehive coke was sold and used for all purposes, of which about 90% was oven coke supplied by furnace plants. The bulk of this coke was retained by producers for use in their own blast furnaces. Furnace plants sold about 2 million tons of coke—25% of the total coke sold commercially. Approximately 50% of the furnace-plant sales was shipped to other blast-furnace plants.

Merchant plants distributed 5.4 million tons of coke in 1972, 97% of which was sold on the open market. Principal markets were blast-furnace operations without coke facilities, independent gray-iron foundries, nonferrous smelters, and chemical plants. A few merchant plants operate coke ovens to supply their own requirements; about 3% of the merchant coke distributed was used by producers. This coke was used principally in chemical plants and affiliated foundries.

One percent of the coke distributed was supplied by beehive plants. The bulk of the beehive coke also was sold to blast-furnace plants.

All States except Alaska, Hawaii, Nevada, and New Hampshire received shipments of coke in 1972. Alabama, Illinois, Indiana, Michigan, New York, Ohio, Pennsylvania, and West Virginia, which are the major iron- and steel-producing States, received about 85% of the total distributed.

The bulk of the coke distributed was blast-furnace coke that was consumed within the producing State, as most blast furnaces are integrated with coke ovens. A few companies shipped coke to affiliated blast furnaces in other States.

About 6% of the coke distributed was shipped to foundries. The chief recipients of foundry coke were the automotive, farm-machinery, machine-tool, heavy-machinery, railroad, and electrical-equipment industries. Most of these industries are concentrated in the East and Midwest. In 1972, the combined consumption of Alabama, Illinois, Indiana, Michigan, New Jersey, New York, Ohio, Pennsylvania, and Wisconsin accounted for about four-fifths of the foundry-coke shipments. Foundry coke also was consumed in 37 other States.

Coke used for miscellaneous applications was widely distributed, with 44 States receiving shipments of other industrial coke. The principal consumers were nonferrous smelters, alkali plants, and plants that manufacture calcium carbide and elemental phosphorus. Alabama, Idaho, Michigan, Ohio, and Pennsylvania received the largest quantities of other industrial coke.

Minor quantities of coke were used for residential heating. This market, which in past years received as much as 10 million tons of coke annually, is virtually nonexistent at this time.

STOCKS

Yearend stocks of coke decreased 16% as the quantity of coke distributed exceeded production by about ½ million tons. Oven-coke plants ended the year with an average 18-day supply at the December rate of production. Normally, beehive plants do not stock coke.

The bulk of the stock was at furnace plants, which had roughly a 17-day supply compared with a 23-day supply at merchant plants. There were no producers stocks of beehive coke at the end of 1972.

Stocks of coke breeze at producers' plants decreased 20% during 1972. Roughly, three-fourths of the breeze on hand was at furnace plants.

Data on stocks are shown in tables 16 and 17.

VALUE AND PRICE

Coke prices increased again during 1972; the average value of receipts for all grades of oven coke reached $40.70 per ton, and beehive coke averaged $22.04 per ton. The 1972 values represented increases of 9% for oven coke and 3% for beehive coke.

All grades of coke increased in price but "other industrial" and "residential heating" cokes, both of which increased about 25% in price, registered the largest percentage increases. Blast-furnace coke, which averaged $30.64 per ton, remained at virtually the same level as in 1971. Foundry coke, however, increased about 7%, to $51.16 per ton.

The large variance in the price of blast-furnace and foundry oven coke was attributed principally to lower recovery yields for foundry coke and to its superior properties, which make it a more valuable product. The differences in the average values of oven and beehive coke were due largely to additional transportation costs of coal delivered to oven-coke plants.

Average receipts, f.o.b. plant, for commercial sales of the different grades of coke, as reported by producers, are shown in table 18.

FOREIGN TRADE

There was a continuing demand for U.S. coke in foreign markets, but exports decreased 18% because of shortages of coke at home. Exports totaled 1.2 million tons, equivalent to about 2% of domestic output.

The principal foreign market was Canada which received 488,006 tons, about 40% of the foreign shipments. Other countries receiving substantial amounts of U.S. coke were West Germany, Mexico, the Netherlands, and Spain. Although coke was shipped to more than 21 countries in 1972, the above countries, with Canada, received nearly four-fifths of the total exports.

The bulk of the coke exported was shipped from the Baltimore, Buffalo, Cleveland, Detroit, Laredo, and Mobile customs districts. However, coke was exported through at least 18 other ports.

Table 19 shows exports of coke by country and customs district for 1970, 1971, and 1972. The total quantities shown for each year are substantially larger than those reported shipped by producers, as shown in table 15, because there were additional shipments to foreign countries by export companies.

Imports were insignificant, amounting to only 0.3% of apparent consumption. Ninety-three percent of the imported coke came from Canada, and almost all of the remainder was from the Republic of South Africa. Import data are shown in table 20.

COKING COALS

QUANTITY AND VALUE OF COAL CARBONIZED

A total of 87.3 million tons of bituminous coal was carbonized at high temperatures for the production of coke in 1972. This quantity was 15% of the 1972 bituminous coal output of the United States, and coke production was the second largest coal market. In addition to bituminous coal, 474,000 tons of anthracite was used in coking-coal blends. Anthracite was used principally in the production of foundry coke to achieve greater size and density, properties that are desirable in coke used for the smelting of iron in foundry cupolas.

The delivered average value of all coal carbonized by oven coke plants in 1972 was $15.73 per ton, and the value of that carbonized by beehive-coke plants averaged $9.85 per ton. The difference in value was attributed mainly to transportation charges for coal shipped to oven-coke plants, as all beehive plants are located at or near the source of the coal they consume. In some instances, transportation costs exceed the value of the coal at the mine; this partially accounts for the high value of the coal consumed in some States.

The average value per ton of coal consumed for coke production at both oven- and beehive-coke plants was about 13% greater than in 1971. Coals delivered to some States, however, had increases in average value per ton ranging up to 30%. The highest coal prices were recorded for Maryland and New York where the delivered value of coals used for coke production by all plants averaged $20.52 per ton.

An overall average of 1.45 tons of coal, valued at $22.81, was required for each ton of oven coke produced in 1972. Beehive ovens required an average of 1.62 tons of coal per ton of coke output, but coal costs averaged only $15.96 per ton because of the lower unit value of the coals charged.

Tables 22 to 25 present data on coals carbonized at oven- and beehive-coke plants.

BLENDING

Blending of coals is standard practice at oven-coke plants because individual coals do not possess all of the properties required for the production of high-quality coke. In general, blending is used to improve the chemical and physical properties of coke, to control the pressure developed during carbonization, to regulate the yield of products, and to broaden the use of lower-quality coals which could not be used alone for metallurgical-grade coke production. Standard oven-coke operating practice is based upon the use of relatively small proportions of low-volatile coals and high percentages of high-volatile coals. High-volatile coals are not used alone because they produce low yields and weak coke. Low-volatile coals, when added to high-volatile coals improve the yield and the physical properties of the coke. However, the proportions of low-volatile coals used must be restricted because they are highly expanding and, if used alone or in large proportions, would damage oven walls when coke was discharged. Some plants add medium-volatile coals or other materials such as anthracite or coal-tar pitch to their high- and low-volatile coals. Additions of medium-volatile coals can regulate the volatile matter in a mix to the desired content, while anthracite and pitch impart strength, size, and density to the coke.

Blending also permits the use of some high-sulfur coals which are otherwise unsuitable for coke production. Such coals can be blended with low-sulfur coals to the extent that the coal mix contains no more total sulfur than that contained in the coals normally used for producing high-quality coke.

The overall proportions of high-, medium-, and low-volatile coals used in coke mixes has varied little in the past decade, but there are wide variations in the proportions of the different types used by individual plants. West Virginia plants and those in the Western States used the largest percentages of high-volatile coals in their blends, while plants in Minnesota and Wisconsin used relatively high percentages of low-volatile coal. Compared with furnace plants, merchant plants used larger percentages of low-volatile coal because this type produces strong foundry coke, which is produced mainly by merchant plants.

Table 26 shows the quantities of coals carbonized at oven-coke plants, by volatile-matter content, for 1968–72. Table 27 shows the volatile-matter content of the coals received by oven-coke plants in various States.

SOURCES

Of the 23 States that produced bituminous coal in 1972, only 11 produced coking coal that was shipped to coke plants. Of this number, only 10 can be considered suppliers of coking coals as the combined shipments of Arkansas producers were only 115,000 tons.

Of the coals received by oven-coke plants, 35% was produced in West Virginia and 27% in Pennsylvania. West Virginia shipments were principally low-volatile coals from McDowell, Wyoming, and Raleigh Counties, medium-volatile coals from McDowell and Nicholas Counties, and high-volatile coals from Boone, Fayette, Kanawha, Logan, Marion, and Mingo Counties. Pennsylvania supplied mainly high-volatile coals from Green and Washington Counties and low-volatile coals from Cambria and Somerset Counties. Pennsylvania and West Virginia coals were widely distributed and used in most of the coke producing States.

Kentucky, which supplied 15% of the shipments to coke plants, was another major supplier. All Kentucky coal shipped to coke plants was high-volatile coal produced mainly in Floyd, Harlan, Letcher, and Pike Counties.

Illinois produced high-volatile coking coals, mainly 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 and Utah, however, supplied most of the coals that were carbonized in California.

Data showing the origin of coals received by oven-coke plants, by volatile-matter content, are shown in table 28, while table 29 shows the source of coals received by oven-coke plants in various States.

CAPTIVE COAL

More than one-half of the coal received by oven-coke plants was produced by company-owned or affiliated mines. This captive coal, ordinarily, does not move in commercial channels. Iron and steel producing companies own the bulk of the captive mines and, in 1972, 57% of the coal received by furnace plants was captive. Some merchant plants also own coal mines, but on 30% of the coal they received in 1972 was their own production.

The quantities of captive coal received by oven-coke plants in 1972 are shown in table 30.

STOCKS

Stocks of bituminous coal at oven-coke plants remained fairly constant throughout the year, ranging from an average supply of 35 to 43 days at each plant. Bituminous stocks reached their highest yearly level during June when month-end quantities totaled 10.1 million tons. The lowest level, 7.9 million tons, was reported at the end of January shortly after a curtailment in bituminous coal production because of a labor strike.

Bituminous stocks at the end of 1972 were 25% higher than when the year began. The 9 million tons on hand at all plants on December 31, 1972, was equivalent to an average supply on hand of 37 days at each plant, at the December rate of consumption.

Only small quantities of anthracite are stocked. Stocks at the end of 1972 totaled only 84,000 tons, 29% less anthracite than was on hand at the end of 1971.

COAL CHEMICALS

The term "coal chemicals" refers to the materials recovered from the volatile matter released from coal during carbonization. Normally, three basic materials—ammonia, tar, and light oil—are recovered at oven-coke plants through a series of complex condensation and absorption processes. The remaining 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 a salt and sold as produced, the basic materials are, in most instances, further processed to yield a number of primary organic chemicals or chemical mixtures of which the most important are benzene, toluene, xylene, solvent naphtha, crude chemical oil, and pitch. Although most oven-coke plants in the United States are equipped to process tar and light oil, the extent to which individual plants produce the various products depends upon economic conditions and the general size of the plant, as yields of the various chemicals are relatively low.

Yields of chemicals vary with the kind of coals carbonized, carbonizing temperatures, and operating techniques and equipment, but approximately 315 pounds of coke-oven gas, 90 pounds of tar, 20 pounds of light oil, and 5 pounds of ammonia are recovered for each ton of coal carbonized. In standard units of measure these quantities amount to about 10,500 cubic feet of coke-oven gas, 10 gallons of tar, and 3 gallons of light oil. Ammonia is recovered as ammonium sulfate at most operations, and the yield per ton of coal is approximately 18 pounds. Data on production and sales of basic chemical materials and derivatives at oven-coke plants in 1972 are shown in table 33.

Table 34 shows the heating value and coal equivalent of products other than coke produced at oven-coke plants. Although the quantities vary from year to year, most of the changes were due to differences in the amount of coal carbonized rather than fluctuations in yields. In terms of heating value, the products, not including coke, recovered in 1972 were roughly equivalent to the heating value of about one-fourth of the coal carbonized in slot ovens. Table 35 shows average values for the chemicals and surplus gas used and sold, compared with the unit values of the coke and breeze produced, from each ton of coal carbonized.

COKE-OVEN GAS

Coke-oven gas has a relatively high calorific value and producers use most of it as fuel for heating coke ovens and other steel- and allied-plant furnaces. Small quantities are also sold for distribution through city mains and for other industrial use.

Gas yields vary but the quantity of gas produced for each ton of coal carbonized in all slot ovens in 1972 was 10,570 cubic feet. This was slightly more than the yield of 10,510 cubic feet recorded for 1971. However, total gas production increased 6% because about 5 million more tons of coal was carbonized in 1972.

Table 37 shows coke-oven gas production by State, the quantities of gas used for heating ovens, and the amount of surplus gas used or sold. Of the total output, 40% was used at plants to heat coke ovens. Gas used otherwise, called surplus gas, is used by producers to fire boilers, transferred to steel or allied plants to heat open-hearth and other metallurgical furnaces, sold for industrial use, or distributed through city mains. A small part of the production was wasted because storage facilities at most plants are limited, and the gas was burned in the atmosphere when production exceeded demand.

Table 38 shows the disposal of surplus gas by the two segments of the oven-coke industry. Whereas about 90% of the surplus gas produced by furnace plants was consumed by producing companies, merchant plants used less than one-half of the surplus gas they produced. The largest portion of the merchant plant surplus was sold for industrial use.

Table 39 shows the quantities of various gases used to heat ovens in each State and the total gas consumption in terms of coke-oven gas equivalent. Coke-oven gas was the principal fuel used for heating slot ovens, but some operators used blast-furnace gas, a mixture of coke-oven and blast-furnace gas, or natural gas for underfiring. Nearly 400 billion cubic feet of coke-oven gas equivalent was so consumed, of which 91% was coke-oven gas, 8% was blast-furnace gas, and the remainder was natural gas.

Surplus coke-oven gas used and sold in 1972 was valued at $144 million, a 7% increase above the 1971 value. No value is reported by producers for coke-oven gas used to heat coke ovens, but applying the average value of $0.27 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 1972 would be $241 million. This amount is equivalent to nearly one-fifth of the total value of the coal carbonized at oven-coke plants.

COKE-OVEN AMMONIA

Coal carbonized at high temperatures releases nitrogen which forms ammonia. This ammonia must be removed from the gas prior to processing and coke plant operators normally recover ammonia as an aqueous solution or as ammonium sulfate or phosphate. However, because of increasing recovery costs and the relatively low value of the products recovered, some plants remove ammonia from the gas stream but do not recover it as a salable product.

Table 40 shows production and sales of ammonia products and yields in 1972 in terms of sulfate equivalent. Although one less plant recovered ammonia in 1972, production was about 4% greater than in 1971, principally because of higher recoveries.

Demand for coke-oven ammonia products declined in 1972 and sales of ammonium sulfate decreased 23% and ammonia liquor sales decreased 19%. The average value per ton, f.o.b. plant, of ammonium sulfate sold, however, increased $3.93 per ton, to $16.12. The total value of all ammonia products sold was $12.3 million, equivalent to 5% of the total value of all coal-chemical materials sold.

COAL TAR AND DERIVATIVES

All oven-coke plants produce tar. However, yields of tar vary widely among plants; in 1972, yields ranged from about 6.6 to 10.7 gallons per ton of coal carbonized. Generally, from 4 to 5% of the weight of the coals carbonized is recovered as tar. High-volatile coals evolve a larger percentage of tar; hence, California, Colorado, Indiana, Ohio, Utah, Pennsylvania and West Virginia, which used the most high-volatile coal in their blends, had the highest tar yields. Conversely, plants using higher percentages of low- and medium-volatile coals and anthracite, such as those mainly producing foundry coke, had the lowest yields.

Production of coal tar at oven-coke plants increased 10% in 1972. The average yield of tar increased slightly to 8.62 gallons per ton of coal, compared with 8.29 gallons in 1971. Table 41 shows the quantities of tar produced, used by producers, sold, and in stock in the various States at the end of 1972.

Coke-plant operators consumed 53% of the tar produced in 1972. Of this quantity, 69% was processed (refined or "topped"), 30% underwent no processing and was burned for fuel, and 1% was used for miscellaneous purposes, such as lining ingot molds, and for road materials and tar paints. The remaining 47% of the production was sold, principally to tar-distilling plants which refined the tar to produce a variety of derivatives.

Most of the coke plants that processed tar in 1972 "topped" tar. In so doing, the low-boiling distillate fraction, consisting mainly of tar acids, bases, and naphthalenes, was separated from the crude tar. The residue, called soft pitch, was, in most instances, burned for fuel. Furnace plants in particular benefit from this method of operation since they can sell the distillate and retain the pitch for use as fuel. This reduces the amount of other fuels that normally they must purchase. However, the relative quantities of tar topped and burned, as well as the quantities sold, depend upon a number of economic factors, such as the availability and current market prices of tar, tar distillates, and other substitute fuels. Most of the merchant plant tar production was sold because these plants have no use for the pitch, which makes up the bulk of the products they recover through topping.

The majority of the plants that processed tar in 1972 recovered only crude chemical oil and a residual tar, or soft pitch. However, some of the larger plants recovered a number of tar derivatives, including creosote oil, cresylic acid, cresols, naphthalene, phenol, pyridine, and medium and hard pitch. Statistics on some of these products could not be shown in this report, but the data were transmitted to the U.S. Tariff Commission, which publishes them along with similar data from tar distillers and petroleum refiners in monthly and annual reports on synthetic organic chemicals.

CRUDE LIGHT OIL AND DERIVATIVES

Light oil is a liquid that contains a number of aromatic hydrocarbons that are extracted from the gas after tar, ammonia, and in some instances, naphthalene have been removed. Crude tar also contains a small amount of light oil, but this usually is not recovered at coke plants. Virtually all light oil produced at coke plants is recovered by an absorption process in which the gas is sprayed with a higher boiling petroleum oil as the gas stream is channeled through absorption towers. After light oil is recovered, it is separated from the absorption oil by direct steam distillation. Approximately 3 gallons of light oil, equal to about 1% of the weight of the coal, is recovered for each ton of coal carbonized. Yields vary with the kind of coals carbonized and with operating conditions but an average of 2.66 gallons of light oil was recovered at plants that extracted light oil in 1972. Most plants recovered light oil, but some found it uneconomical to remove the light oil and left it in the gas to be burned as fuel. Yields per ton of coal increased at both merchant and furnace plants in 1972.

Producers sold 41% of their crude light oil output in 1972. The large increase in light oil sales in recent years is attributed principally to the inability of some plants to produce derivatives that meet the more rigid specifications established for these products. Such plants sell light oil to petroleum-refining companies which process it along with petroleum fractions into benzene, toluene, and a number of other chemical intermediates. Data on light oil and total derived products produced and sold in the various States are shown in table 42.

As with other coal-chemical materials, yields of products derived from light oil vary, but approximately 85% of the light oil processed is recovered as salable products. Yields of the various derivatives recovered through refining during 1972 and for prior years are shown in table 43.

Table 44 shows the quantities of the various grades of benzene and toluene produced at coke plants, while table 45 shows the principal light-oil derivatives produced and sold and yields of the various products by State. About 95% of the benzene is specification grade. In past years, large amounts of motor-grade benzene were produced for use in gasolines to increase antiknock properties, but present petroleum-refining techniques have all but eliminated this use for benzene. Production of all light oil derivatives was greater than in 1971, principally because a larger amount of light oil was refined.

WORLD REVIEW

World production of metallurgical coke in 1972 was estimated at 375 million short tons. This quantity was slightly higher than the 1971 output and the increase was attributed largely to small production gains in Poland, the United States, and the U.S.S.R.

Europe, with 58% of the total, led in world production. European output was about 1% less than in 1971, mainly, because of a substantial decrease in West German production. Asia, with seven producing countries, ranked second in output while North America, with only three producing countries, ranked third.

The Soviet Union, with nearly one-fourth of the world output, was the largest producer of coke. Soviet production increased 2% over that of 1971 and the estimated 88 million tons of coke and breeze produced in 1972 was a record output for the country. Metallurgical coke production, however, probably totaled about 84 million tons as an estimated 4 million tons of the production was breeze.

The United States, with 16% of the world total, ranked second in production, and Japan, with 11%, ranked third. The United States had a 5% production increase, but Japan's output was 1% below the level recorded in 1971.

Other leading coke-producing countries in order of output were West Germany, the People's Republic of China, the United Kingdom, and Poland. Although metallurgical-grade coke was produced in 32 other countries, the production of these countries combined with that of the U.S.S.R., the United States, and Japan accounted for more than three-quarters of the world production.

In addition to the metallurgical-grade coke, which is produced at high-temperatures in conventional slot- and beehive-coke ovens, there was 11 million tons of other coke that was produced at high, medium, and low temperatures in vertical and horizontal retorts and other types of carbonizing equipment. Commonly referred to as "gashouse" or "soft" coke, this material is not suitable for most metallurgical applications but is used principally for domestic heating, chemical processing, and gas production. Production of "gashouse" coke has been declining in recent years and the 1972 world output was only about one-fourth as large as a decade ago.

TECHNOLOGY

Studies [2] performed by the British Coke Research Association indicate that a reasonable estimate of the mean size of coke may be obtained from a singular linear dimension characteristic of the size of coke particles and its relationship to the mean size of the coke. Size is an important physical property of coke that determines, partially, the extent that certain cokes may be used effectively in particular applications. The size distribution of a sample of coke is assessed traditionally by a method, either mechanical or manual, which separates the coke by screening into discrete groups of pieces of similar size range. In this work, an expression was derived that made it possible to calculate the mean size of coke from the weight of a known number of coke particles. The expression was shown to be valid for coke within the overall size range of 20 to 160 millimeters and varying in apparent relative density from 0.84 to 1.03.

A laboratory investigation,[3] also by the British Coke Research Association, showed that both the quantity and particle size of breeze additions to coking coal charges influenced coke reactivity. Specifically, these studies showed that a coal charge containing up to 10% fine breeze (particle size of less than 38 micromillimeters) produced more reactive coke than the charge without breeze and that the reactivity for coke from a charge containing similar proportions of coarse breeze (particle size of from 1,200 to 210 micromillimeters) was less than for the charge with additions of fine breeze. Coke reactivity for charges of more than 10% breeze appeared to be modified; however, the breeze additions resulted in changes in coke porosity and these effects were more pronounced for breeze additions of particle size greater than about 120 micromillimeters.

A recent Bureau of Mines study [4] has found that cokes obtained from carbonization of certain high-volatile coals, when blended with fluidized-bed char and coke breeze, were significantly larger and stronger than cokes made from the same coals without such additions. In numerous bench-scale and other laboratory tests using Illinois No. 6 and a Kentucky High Splint coal, it was demonstrated that coke strength was improved most with a 12% addition of char and coke breeze in equal proportions and that such addition to the base coals was just as effective in improving the strength of coke produced as a 40% addition of high-quality low-volatile coal. Introduction of a proportion of low-volatile coal to the char-breeze Illinois coal blend improved the coke strength even further, although a similar addition to the High Splint blend did not result in as great an improvement in coke strength. The results of these experiments suggest that the use of premium low-volatile coking coals in certain metallurgical coking-coal mixes could be eliminated by additions of char and coke breeze.

Developmental work at coke plants continued to be focused upon systems for reducing atmospheric pollution. A number of systems and practices, including pipeline charging, the use of door machine hoods, and a smokeless charging system, developed through supporting research by the American Iron and Steel Institute, the Environmental Protection Agency, and several steel companies, have been installed at a number of plants. All, however, are experimental in nature and air-pollution control continues as the major operating problem of coke plants.

Relief from the pollution problems associated with coke quenching might possibly be obtained through the use of a Soviet process [5] for dry-quenching, which was described and demonstrated recently at a Symposium on Soviet Anti-Pollution Technology. This process features a completely closed system that, it was claimed, quenches coke without pollution, produces coke with improved properties, increases pig iron output per ton of coke and conserves energy by steam generation within the system. It was claimed, also, that this process has effectively eliminated quenching pollution problems at 28 Soviet coke-

[2] British Coke Research Association. The Estimation of the Mean Size of Coke. Coke Res. Rept. 67, September 1971. Pp. 1–23.

[3] British Coke Research Association. The Effect of the Amount and Particle Size of Breeze in the Coal Charge on the Porosity and Reactivity of Experimental Cokes. Coke Res. Rept. 68, December 1971. Pp. 1–7.

[4] Kovalik, M. J., D. E. Wolfson, and L. Mafrica. Better Coke by Using Antifissurants. Results for Illinois No. 6 and High Splint Coals. BuMines RI 7718, 1973, 20 pp.

[5] A Pollution Free System for Dry-Quenching of Coke. Symposium on Soviet Anti-Pollution Technology, Washington, D.C., May 9, 1973.

oven batteries that have been fitted with the system and the system has been so successful that 19 more dry-quenching units are under construction in the U.S.S.R.

A $25 million experimental plant that will produce 500 tons of form coke per day is now under construction at Sparrows Point, Md. A joint venture of the Bethlehem, National, and Republic Steel Corporations and Consolidation Coal Company, the plant, reportedly, will produce form coke suitable for blast furnace use by hot-pelletizing fine coal, after which the product is calcined. The system, which is fully enclosed, will minimize the problems of air and water pollution now experienced in conventional coke making.

A system for disposing of waste liquids from coke plant operations has been installed at the Alan Wood Steel Company coke plant at Swedeland, Pa. With this process, waste liquid is passed through successive stages of distillation and evaporation, yielding vapors and a concentrated solution of dissolved solids. The vapors and dissolved solids are incinerated; the distillate is purified by activated carbon, producing clean water.

Table 2.—Statistical summary of the coke industry in the United States in 1972

	Slot ovens	Beehive ovens	Total
Coke produced:			
At merchant plants ... thousand short tons	5,626	(1)	(1)
At furnace plants [2] ... do	54,228	(1)	(1)
Total [3] ... do	59,853	654	60,507
Breeze produced ... do	4,261	W	4,261
Coal carbonized:			
Bituminous:			
Thousand short tons	86,213	1,059	87,272
Value (thousands)	$1,356,879	$10,428	$1,367,307
Average per ton	$15.74	$9.85	$15.67
Anthracite:			
Thousand short tons	474	--	474
Value (thousands)	$7,066	--	$7,066
Average per ton	$14.91	--	$14.91
Total:			
Thousand short tons	86,687	1,059	87,746
Value (thousands)	$1,363,945	$10,428	$1,374,373
Average per ton	$15.73	$9.85	$15.66
Average yield in percent of total coal carbonized:			
Coke	69.05	61.76	68.96
Breeze (at plants actually recovering)	4.92	W	4.92
Coke used by producing companies:			
In blast furnaces:			
Thousand short tons	52,738	--	52,738
Value (thousands)	$1,705,269	--	$1,705,269
In foundries:			
Thousand short tons	385	--	385
Value (thousands)	$18,554	--	$18,554
For other industrial uses:			
Thousand short tons	296	--	296
Value (thousands)	$9,146	--	$9,146
Breeze used by producing companies:			
In steam plants:			
Thousand short tons	265	--	265
Value (thousands)	$2,396	--	$2,396
In agglomerating plants:			
Thousand short tons	1,305	--	1,305
Value (thousands)	$16,095	--	$16,095
For other industrial uses:			
Thousand short tons	704	--	704
Value (thousands)	$6,759	--	$6,759
Coke sold (commercial sales):			
To blast furnaces:			
Thousand short tons	2,613	669	3,282
Value (thousands)	$80,053	$14,745	$94,798
Average per ton	$30.64	$22.01	$28.88
To foundries:			
Thousand short tons	3,057	--	3,057
Value (thousands)	$156,387	--	$156,387
Average per ton	$51.16	--	$51.16
To other industrial plants:			
Thousand short tons	1,261	(4)	1,261
Value (thousands)	$46,571	(4)	$46,571
Average per ton	$36.93	(4)	$36.93
For residential heating:			
Thousand short tons	64	--	64
Value (thousands)	$1,732	--	$1,732
Average per ton	$27.06	--	$27.06

See footnotes at end of table.

Table 2.—Statistical summary of the coke industry in the United States in 1972—Continued

	Slot ovens	Beehive ovens	Total
Breeze sold (commercial sales):			
Thousand short tons	2,113	W	2,113
Value (thousands)	$22,366	W	$22,366
Average per ton	$10.59	W	$10.59
Coal-chemical materials produced:			
Crude tar:			
Thousand gallons	747,186	--	747,186
Gallons per ton of coal	8.62	--	8.62
Ammonia: [5]			
Thousand short tons	656	--	656
Pounds per ton of coal	18.93	--	18.93
Crude light oil:			
Thousand gallons	214,201	--	214,201
Gallons per ton of coal	2.66	--	2.66
Gas:			
Million cubic feet	916,011	--	916,011
Thousand cubic feet per ton of coal	10.57	--	10.57
Percent burned in coking process	39.51	--	39.51
Percent surplus used or sold	58.35	--	58.35
Percent wasted	2.14	--	2.14
Value of coal-chemical materials used or sold:			
Crude tar and derivatives:			
Used thousands	$46,018	--	$46,018
Sold do	$63,041	--	$63,041
Ammonia products [6] do	$12,322	--	$12,322
Crude light oil and derivatives [7] do	$30,382	--	$30,382
Surplus gas	$143,893	--	$143,893

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 furnaces" to avoid disclosing individual company data.
[5] In terms of sulfate equivalent.
[6] Includes ammonium sulfate, ammonia liquor (NH_3 content), and diammonium phosphate.
[7] Includes intermediate light oil.

Table 3.—Summary of oven-coke operations in the United States in 1972, by State

State	Plants in existence Dec. 31	Coal carbonized (thousand short tons)	Yield of coke from coal (%)	Coke produced (thousand short tons)
Alabama	7	7,551	70.92	5,355
California, Colorado, Utah	3	4,665	63.35	2,955
Illinois	4	3,312	62.95	2,085
Indiana	6	13,788	66.66	9,191
Kentucky, Missouri, Tennessee, Texas	5	2,984	70.34	2,099
Maryland and New York	4	7,817	69.53	5,435
Michigan	3	4,992	73.65	3,677
Minnesota and Wisconsin	3	1,138	71.84	816
Ohio	12	12,725	69.72	8,860
Pennsylvania	12	22,886	69.34	15,869
West Virginia	3	4,828	72.70	3,510
Total 1972 [1]	62	86,687	69.05	59,853
At merchant plants	14	7,793	72.19	5,626
At furnace plants	48	78,893	68.74	54,228
Total 1971	62	81,952	69.14	56,664

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

Table 4.—Summary of beehive-coke operations in the United States in 1972, by State

State	Plants in existence Dec. 31	Coal carbonized (thousand short tons)	Yield of coke from coal (%)	Coke produced (thousand short tons)
Pennsylvania and Virginia	6	1,059	61.76	654
Total 1972	6	1,059	61.76	654
Total 1971	6	1,289	59.89	772

Table 5.—Production of oven and beehive coke in the United States, by month

(Thousand short tons)

Month	1971 Total [1]	1971 Daily average [2]	1972 Total [1]	1972 Daily average [2]
OVEN COKE				
January	5,647	182	4,763	154
February	5,054	r 181	4,651	160
March	5,752	186	5,076	164
April	5,621	187	5,091	170
May	5,693	184	5,237	169
June	5,268	176	4,976	166
July	4,816	155	5,024	162
August	3,455	111	5,088	164
September	3,976	133	4,822	161
October	3,961	128	5,026	162
November	3,220	107	4,914	164
December	4,200	135	5,183	167
Total [1]	56,664	155	59,853	164
BEEHIVE COKE				
January	66	2	49	2
February	76	3	53	2
March	78	3	51	2
April	68	2	55	2
May	77	2	51	2
June	76	3	53	2
July	67	2	49	2
August	55	2	54	2
September	54	2	54	2
October	52	2	53	2
November	46	2	62	2
December	56	2	70	2
Total [1]	772	2	654	2
TOTAL				
January	5,713	184	4,812	155
February	5,130	r 183	4,704	162
March	5,830	188	5,127	165
April	5,689	190	5,146	172
May	5,770	186	5,287	171
June	5,344	178	5,029	168
July	4,883	158	5,073	164
August	3,510	113	5,142	166
September	4,030	134	4,877	163
October	4,013	129	5,079	164
November	3,266	109	4,976	166
December	4,256	137	5,253	169
Total [1]	57,436	157	60,507	165

r Revised.

[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	1971		1972	
	Merchant plants	Furnace plants	Merchant plants	Furnace plants
PRODUCTION				
January	492	5,155	482	4,281
February	443	4,611	460	4,191
March	505	5,247	490	4,586
April	495	5,126	467	4,625
May	502	5,191	486	4,751
June	486	4,783	468	4,508
July	420	4,393	467	4,558
August	480	2,975	463	4,626
September	478	3,498	453	4,369
October	463	3,498	473	4,553
November	368	2,852	462	4,452
December	434	3,766	455	4,728
Total [1]	5,567	51,097	5,626	54,228
DAILY AVERAGE				
January	16	166	16	138
February	15	159	16	145
March	16	169	16	184
April	17	171	16	154
May	16	167	16	153
June	16	159	16	150
July	13	142	15	147
August	15	96	15	149
September	16	117	15	146
October	15	113	15	147
November	12	95	15	148
December	14	121	15	153
Average for year	15	140	15	148

[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 [2]	Merchant plants	Furnace plants	Merchant plants	Furnace plants
1968	[3] 16	48	5,879	56,999	9.4	90.6
1969	[3] 16	49	5,919	58,129	9.2	90.8
1970	[3] 16	49	5,915	59,739	9.0	91.0
1971	16	49	5,567	51,097	9.8	90.2
1972	14	49	5,626	54,228	9.4	90.6

[1] Includes plants operating any part of year.
[2] Includes one tar-refining plant.
[3] Includes one light oil refining plant.

Table 8.—Production of coke in the United States, by State

(Thousand short tons)

State	1971	1972
OVEN COKE		
Alabama	5,363	5,355
California, Colorado, Utah	2,981	2,955
Illinois	2,144	2,085
Indiana	7,832	9,191
Kentucky, Missouri, Tennessee, Texas	1,955	2,099
Maryland, New Jersey, New York	5,985	[1] 5,435
Michigan	3,780	3,677
Minnesota and Wisconsin	784	818
Ohio	7,575	8,860
Pennsylvania	15,261	15,869
West Virginia	3,006	3,510
Total [2]	56,664	59,853
BEEHIVE COKE		
Pennsylvania	772	654
Virginia	(3)	(3)
Total	772	654
Grand total	57,436	60,507

[1] Does not include New Jersey.
[2] Data may not add to totals shown because of independent rounding.
[3] Included with Pennsylvania to avoid disclosing individual company data.

Table 9.—Breeze recovered at coke plants in the United States in 1972, by State

(Thousand short tons and thousand dollars)

State	Yield per ton of coal[1] (%)	Produced	Used by producers						Sold		On hand Dec. 31
		Quantity	In steam plants		In agglomerating plants		For other industrial use		Quantity	Value	
			Quantity	Value	Quantity	Value	Quantity	Value			
OVEN COKE											
Alabama	5.07	383	--	--	(2)	(2)	24	395	233	3,412	29
California, Colorado, Utah	4.66	217	(2)	(2)	142	1,924	(2)	(2)	(2)	(2)	W
Illinois	5.62	186	(2)	(2)	(2)	(2)	30	228	116	1,005	22
Indiana	6.52	899	--	--	230	2,665	144	1,541	504	5,109	80
Kentucky, Missouri, Tennessee, Texas	5.52	165	(2)	(2)	--	--	69	739	39	586	75
Maryland and New York	5.10	399	124	1,118	(2)	(2)	(2)	(2)	(2)	(2)	212
Michigan	4.44	222	--	--	--	--	(2)	(2)	(2)	(2)	W
Minnesota, Wisconsin, West Virginia	6.15	367	(2)	(2)	(2)	(2)	103	794	(2)	(2)	76
Ohio	5.09	647	(2)	(2)	15	139	86	760	562	5,825	57
Pennsylvania	3.40	777	(2)	(2)	430	6,240	116	1,071	176	1,763	107
Undistributed	--	--	142	1,277	489	5,126	132	1,230	484	4,666	53
Total 1972[3]	4.92	4,261	265	2,396	1,305	16,095	704	6,759	2,113	22,366	711
At merchant plants[3]	6.27	488	100	896	--	--	212	1,783	217	3,051	199
At furnace plants	4.78	3,773	165	1,500	1,305	16,095	492	4,976	1,896	19,315	513
Total 1971	4.94	4,048	309	2,221	1,582	18,558	650	5,862	1,863	21,057	888
BEEHIVE COKE											
Pennsylvania and Virginia, 1972	W	W	--	--	--	--	--	--	W	W	--
Total 1971	8.84	16	--	--	--	--	--	--	16	31	--

W Withheld to avoid disclosing individual company confidential data.
[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] Data may not add to totals shown because of independent rounding.

Table 10.—Oven- and beehive-coke breeze used and sold in the United States, by use

(Thousand short tons)

Year	Used by producers			Sold	Average value per ton
	In steam plants	In agglomerating plants	For other industrial use		
1968	508	1,634	589	1,364	7.34
1969	439	1,650	775	1,538	8.13
1970	366	1,948	704	[1] 2,067	9.74
1971	309	1,582	650	1,879	10.80
1972	265	1,305	704	[1] 2,113	10.59

[1] Does not include beehive-coke breeze sold (to avoid disclosing individual company 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]		Consumption: All other purposes	
						Quantity	%	Quantity	%
1968	63,653	94	792	+517	62,438	56,238	90.1	6,200	9.9
1969	64,757	173	1,629	−2,865	66,166	60,176	90.9	5,990	9.1
1970	66,525	153	2,478	+993	63,207	58,151	92.0	5,056	8.0
1971	57,436	174	1,509	[r] −588	[r] 56,689	51,498	90.8	5,206	9.2
1972	60,507	185	1,232	−586	60,029	54,607	91.0	5,422	9.0

[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 (%)	Coking coal per short ton of pig iron and ferroalloys (pounds, calculated)
1968	1,263.4	69.8	1,810.0
1969	1,260.4	69.4	1,816.1
1970	1,266.6	69.1	1,833.0
1971	1,260.8	69.0	1,827.2
1972	1,221.6	69.1	1,771.5

[1] American Iron and Steel Institute; consumption of coke per ton of pig iron only, excluding furnaces making ferroalloys, was 1,248 in 1968; 1,252 in 1969; 1,260 in 1970; 1,254 in 1971; and 1,216.2 in 1972.

Table 13.—Oven coke produced in the United States, used by producers, and sold in 1972, by State

(Thousand short tons and thousand dollars)

State	Produced	Used by producing companies				Commercial sales	
		In blast furnaces		For other purposes [1]		To blast-furnace plants	
	Quantity	Quantity	Value	Quantity	Value	Quantity	Value
Alabama	5,355	3,810	92,841	275	11,238	548	15,416
California, Colorado, Utah	2,955	2,812	85,398	(2)	(2)	--	--
Illinois	2,085	2,042	67,068	(2)	(2)	(2)	(2)
Indiana	9,191	8,577	203,872	(2)	(2)	(2)	(2)
Kentucky, Missouri, Tennessee, Texas	2,099	(2)	(2)	(2)	(2)	(2)	(2)
Maryland and New York	5,435	5,115	196,574	91	3,913	(2)	(2)
Michigan	3,677	(2)	(2)	(2)	(2)	(2)	(2)
Minnesota, West Virginia, Wisconsin	4,328	3,662	121,861	(2)	(2)	(2)	(2)
Ohio	8,860	7,633	246,445	71	2,433	641	20,327
Pennsylvania	15,869	15,427	575,289	46	1,814	(2)	(2)
Undistributed	--	3,662	115,921	198	8,301	1,424	44,266
Total 1972 [3]	59,853	52,738	1,705,269	681	27,699	2,613	80,053
At merchant plants	5,626	--	--	182	7,886	1,675	51,619
At furnace plants	54,228	52,738	1,705,269	498	19,813	938	28,434
Total 1971	56,664	50,260	1,494,297	601	21,757	2,947	89,851

State	Commercial sales—Continued							
	To foundries		To other industrial plants		For residential heating		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Alabama	670	32,999	282	15,371	(2)	(2)	(2)	(2)
California, Colorado, Utah	(2)	(2)	(2)	(2)	--	--	(2)	(2)
Illinois	--	--	--	--	--	--	(2)	(2)
Indiana	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Kentucky, Missouri, Tennessee, Texas	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Maryland and New York	(2)	(2)	(2)	(2)	--	--	(2)	(2)
Michigan	(2)	(2)	(2)	(2)	--	--	(2)	(2)
Minnesota, West Virginia, Wisconsin	376	19,900	170	5,280	(2)	(2)	569	25,934
Ohio	(2)	(2)	(2)	(2)	--	--	1,102	41,242
Pennsylvania	463	23,542	194	6,089	(2)	(2)	759	32,502
Undistributed	1,549	79,946	616	19,832	64	1,732	4,566	185,067
Total 1972 [3]	3,057	156,387	1,261	46,571	64	1,732	6,996	284,743
At merchant plants	2,780	142,881	733	25,164	39	1,216	5,226	220,881
At furnace plants	277	13,507	528	21,407	26	516	1,769	63,864
Total 1971	2,928	140,475	1,248	37,127	61	1,809	7,184	268,762

[1] Comprises 885,000 tons valued at $18,554,000 used in foundries; 296,000 tons valued at $9,146,000 for other purposes.
[2] Included with "Undistributed" to avoid disclosing individual company data.
[3] Data may not add to totals shown because of independent rounding.

Table 14.—Production and sales of beehive coke in the United States in 1972

(Thousand short tons and thousand dollars)

State	Produced	Commercial sales					
		To blast-furnace plants		To foundries		To other industrial plants	
	Quantity	Quantity	Value	Quantity	Value	Quantity	Value
Pennsylvania and Virginia	654	669	14,745	--	--	[1]	[1]
Total 1972	654	669	14,745	--	--	[1]	[1]
Total 1971	772	757	16,237	--	--	[1]	[1]

State	Commercial sales—Continued			
	For residential heating		Total	
	Quantity	Value	Quantity	Value
Pennsylvania and Virginia	--	--	669	14,745
Total 1972	--	--	669	14,745
Total 1971	--	--	757	16,237

[1] Included with beehive-coke sold "to blast-furnace plants" to avoid disclosing individual company data.

Table 15.—Distribution of oven and beehive coke and breeze in 1972 [1]

(Thousand short tons)

Consuming State	Coke					Breeze
	To blast-furnace plants	To foundries	To other industrial plants	For residential heating	Total [2]	
Alabama	3,920	354	132	7	4,414	238
Alaska	--	--	--	--	--	(³)
Arizona	--	1	4	--	5	(³)
Arkansas	--	3	2	--	4	(³)
California	1,077	46	51	--	1,173	40
Colorado	680	8	25	4	717	78
Connecticut	--	9	(³)	--	9	(³)
Delaware	--	--	(³)	--	(³)	--
Florida	--	2	23	(³)	26	24
Georgia	--	14	4	(³)	18	1
Idaho	--	(³)	140	--	140	3
Illinois	2,993	189	16	4	3,201	278
Indiana	8,101	168	33	18	8,320	675
Iowa	--	97	1	--	99	--
Kansas	--	12	(³)	(³)	13	(³)
Kentucky	1,128	31	26	(³)	1,186	98
Louisiana	--	1	55	--	57	(³)
Maine	--	1	(³)	--	1	--
Maryland	2,470	17	5	--	2,492	320
Massachusetts	--	32	(³)	--	33	--
Michigan	4,082	804	157	2	5,046	221
Minnesota	211	15	60	--	286	28
Mississippi	--	(³)	1	(³)	1	4
Missouri	--	22	58	(³)	80	59
Montana	--	(³)	20	--	20	28
Nebraska	--	2	10	--	11	--
New Jersey	--	84	51	--	134	22
New Mexico	--	--	(³)	1	1	(³)
New York	2,513	139	89	--	2,741	247
North Carolina	--	17	(³)	(³)	17	8
North Dakota	--	(³)	(³)	--	1	--
Ohio	8,801	476	132	1	9,410	648
Oklahoma	--	5	1	--	6	7
Oregon	(³)	1	15	(³)	16	9
Pennsylvania	14,940	267	165	25	15,397	710
Rhode Island	--	2	8	--	10	(³)
South Carolina	--	7	31	(³)	39	19
South Dakota	--	1	--	--	1	--
Tennessee	3	86	48	(³)	137	82
Texas	757	88	62	(³)	907	57
Utah	1,075	23	7	--	1,105	52
Vermont	--	2	--	--	2	--
Virginia	--	93	3	--	95	53
Washington	--	2	6	--	8	3
West Virginia	3,150	11	48	--	3,209	216
Wisconsin	--	151	3	1	155	63
Wyoming	--	--	6	--	6	(³)
Total [2]	55,904	3,283	1,499	64	60,750	4,292
Exported	114	159	60	--	333	97
Grand total	56,018	3,442	1,559	64	61,083	4,389

[1] Based upon reports from producers showing destination and principle end use of coke used and sold. Does not include imported coke which totaled 185,000 tons in 1972.
[2] Data may not add to totals shown because of independent rounding.
[3] Less than ½ unit.

Table 16.—Producers' stocks of coke and breeze in the United States on Dec. 31, 1972, by State

(Thousand short tons)

State	Coke: Blast furnace	Coke: Foundry	Coke: Residential heating and other	Coke: Total [1]	Breeze
OVEN COKE					
Alabama	281	5	(2)	286	29
California, Colorado, Utah	198	--	--	198	49
Illinois	126	--	--	126	22
Indiana	283	13	8	304	80
Kentucky, Missouri, Tennessee, Texas	138	5	26	169	75
Maryland and New York	156	6	17	179	212
Michigan	179	3	4	186	4
Minnesota and Wisconsin	164	9	10	183	71
Ohio	350	15	3	368	57
Pennsylvania	789	82	45	917	107
West Virginia	25	--	--	25	5
Total 1972 [1]	2,690	137	113	2,941	711
At merchant plants	135	116	100	351	199
At furnace plants	2,555	21	14	2,590	513
Total 1971	3,399	55	55	3,510	888
BEEHIVE COKE					
Pennsylvania	--	--	--	--	--
Virginia	--	--	--	--	--
Total:					
1972	--	--	--	--	--
1971	17	--	--	17	--

[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 1971	At merchant plants 1972	At furnace plants 1971	At furnace plants 1972	Total [1] 1971	Total [1] 1972
January	92	148	4,149	3,437	4,241	3,585
February	60	158	3,994	3,454	4,054	3,611
March	40	184	3,802	3,139	3,842	3,323
April	40	211	3,559	2,900	3,599	3,111
May	50	227	3,293	2,795	3,343	3,022
June	60	263	3,093	2,643	3,153	2,907
July	98	340	3,303	2,748	3,401	3,089
August	116	355	3,702	2,831	3,818	3,185
September	151	384	3,919	2,818	4,070	3,202
October	166	360	3,977	2,729	4,143	3,089
November	127	349	3,469	2,662	3,596	3,011
December	134	351	3,376	2,590	3,510	2,941

[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					
1968	$16.40	$32.43	$15.97	$17.96	$22.00
1969	19.14	35.29	18.25	18.67	24.50
1970	25.05	40.83	22.74	20.19	29.97
1971	30.49	47.98	29.75	21.46	37.41
1972	30.64	51.16	36.93	27.06	40.70
BEEHIVE COKE					
1968	15.14	6.84	14.80	18.60	15.00
1969	16.31	6.84	15.93	16.52	16.23
1970	19.77	18.98	23.01	--	19.89
1971	21.24	--	W	--	21.45
1972	22.01	--	W	--	22.04

W Withheld to avoid disclosing individual company confidential data.

Table 19.—Coke exported from the United States, by country and customs district

	1970		1971		1972	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
COUNTRY						
Algeria	--	--	40,678	$692	--	--
Angola	13,632	$714	--	--	--	--
Argentina	7,390	453	6,680	300	--	--
Belgium-Luxembourg	45,453	1,694	27,983	320	34,041	$608
Brazil	76,978	3,564	37,801	1,630	11,775	699
Bulgaria	141,147	7,719	29,126	1,774	--	--
Canada	347,122	10,698	492,391	16,289	488,006	14,996
Chile	23,063	1,228	--	--	--	--
Dominican Republic	373	12	210	5	448	11
Finland	16,609	276	--	--	--	--
France	5,621	275	--	--	262	6
Germany, West	42,636	1,348	85,411	1,402	141,021	1,989
India	745	29	271	12	614	26
Iran	--	--	688	51	68	4
Italy	134,790	1,938	34,524	414	7,652	106
Japan	275,147	3,675	138,496	2,210	88,236	1,412
Liberia	--	--	11,810	187	--	--
Mexico	375,996	9,827	80,248	2,831	105,181	4,049
Netherlands	102,217	1,242	151,081	1,628	129,654	1,172
Norway	6,017	219	19,397	366	8,471	215
Peru	38,985	1,731	90,714	3,888	1,383	86
Portugal	80,367	3,079	52,028	2,090	--	--
Romania	388,983	14,002	28,043	1,357	57,950	1,313
Singapore	--	--	--	--	805	25
Spain	78,180	1,303	--	--	106,839	1,683
Tunisia	19,522	1,077	--	--	--	--
United Kingdom	371	7	23,244	263	3,704	229
Venezuela	244,588	11,616	119,014	6,039	32,174	1,664
Yugoslavia	8,075	391	37,579	998	12,270	383
Zaire	3,049	162	--	--	--	--
Other	1,282	48	1,222	73	1,079	44
Total	2,478,338	78,327	1,508,639	44,819	1,231,633	30,720
CUSTOMS DISTRICT						
Baltimore	501,485	16,438	199,103	5,333	127,156	2,572
Buffalo	153,427	5,012	295,761	9,191	230,965	8,796
Cleveland	18,769	160	67,714	565	133,412	1,051
Chicago	13,965	183	7,569	65	64,037	753
Detroit	242,292	5,296	243,407	6,287	189,723	4,683
Duluth	1,322	54	2,028	91	14,163	185
El Paso	1,532	41	30	1	158	8
Great Falls	1,340	36	859	18	170	9
Houston	1,235	49	1,191	27	2,047	93
Laredo	372,724	9,728	79,084	2,781	96,899	3,852
Los Angeles	37,707	475	50	3	53,054	588
Miami	164	4	394	13	367	7
Mobile	401,020	10,539	291,529	7,970	146,551	3,235
New Orleans	30,080	721	1,517	70	5,050	297
New York City	223	9	214	7	580	20
Nogales	223	11	401	22	514	24
Norfolk	181,936	8,059	121,618	4,347	53,650	887
Ogdensburg	20,546	586	17,455	518	3,312	77
Pembina	22,692	874	17,164	815	16,563	875
Philadelphia	465,180	19,687	154,556	6,388	81,667	2,357
Portland, Maine	--	--	241	4	--	--
St. Albans	1,370	22	160	6	--	--
San Diego	1,517	47	733	28	948	31
San Francisco	--	--	(1)	1	6,744	136
Seattle	7,589	296	5,818	255	3,882	183
Other	--	--	43	13	21	1
Total	2,478,338	78,327	1,508,639	44,819	1,231,633	30,720

1 Less than ½ unit.

Table 20.—U.S. imports for consumption of coke by country and customs district

	1970		1971		1972	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
COUNTRY						
Canada	146,275	$2,784	170,784	$4,593	171,297	$4,276
France	2,498	255	--	--	--	--
Germany, West	3,888	456	3,036	444	268	42
Netherlands	218	36	--	--	--	--
South Africa, Republic of	--	--	94	1	13,457	331
United Kingdom	--	--	--	--	1	(1)
Total	152,879	3,531	173,914	5,038	185,023	4,649
CUSTOMS DISTRICT						
Boston	--	--	--	--	1	(1)
Buffalo	9,339	171	967	25	3,110	66
Charleston	--	--	--	--	13,457	331
Chicago	--	--	11,498	339	20,276	730
Cleveland	--	--	--	--	25,768	298
Detroit	22,102	408	88,835	2,471	21,437	342
Duluth	8,156	53	330	3	--	--
Great Falls	93,504	1,964	69,022	1,749	100,187	2,814
Honolulu	274	14	110	7	165	11
Mobile	1,810	176	--	--	--	--
New Orleans	3,870	484	3,031	439	103	31
Ogdensburg	214	10	--	--	229	13
Pembina	7,204	63	58	1	--	--
Portland, Maine	14	(1)	33	1	34	1
St. Albans	21	(1)	15	(1)	256	12
San Juan	--	--	15	3	--	--
Savannah	650	74	--	--	--	--
Seattle	5,721	114	--	--	--	--
Total	152,879	3,531	173,914	5,038	185,023	4,649

[1] Less than ½ unit.

Table 21.—Coke: World production by type and country—Continued

(Thousand short tons)

Kind of coke and country [1]	1970	1971	1972 [p]
METALLURGICAL COKE [2]			
North America:			
Canada [3] [4]	5,669	5,105	5,207
Mexico	1,433	1,751	[e] 1,861
United States	66,525	57,436	60,507
South America:			
Argentina [3] [e]	397	397	397
Brazil	[r] 1,780	1,483	1,841
Chile	[r] 334	345	340
Colombia	[r] 549	513	578
Peru	32	[e] 32	[e] 12
Europe:			
Austria [3]	1,949	1,806	1,836
Belgium	7,847	7,477	7,980
Bulgaria	923	--	--
Czechoslovakia	11,316	11,543	11,770
Finland [4]	132	123	95
France [3]	[r] 15,600	13,784	12,686
Germany, East	2,835	2,553	[e] 2,315
Germany, West	43,997	41,379	37,977
Greece	20	193	295
Hungary	855	862	856
Italy	7,766	7,668	[e] 7,551
Netherlands [3]	[r] 2,199	2,094	[e] 2,133
Norway	343	363	342
Poland	[r] 15,339	15,631	17,502
Romania	1,179	[e] 1,179	[e] 1,179
Spain [5]	4,441	4,482	4,839
Sweden	584	550	713
U.S.S.R. [3]	83,114	86,340	87,909
United Kingdom	22,358	21,066	18,967
Yugoslavia	[r] 1,443	1,430	1,432
Africa:			
Egypt, Arab Republic of [e]	350	350	350
Rhodesia, Southern [e]	270	270	270
South Africa, Republic of	3,511	[e] 3,530	[e] 3,600

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]	1970	1971	1972 p
Asia:			
China, People's Republic of e	20,000	20,000	20,000
India [6]	r 9,875	9,893	e 10,132
Iran [7]	60	63	e 66
Japan	r 41,606	42,325	41,898
Korea, North e	2,400	2,400	2,400
Taiwan	r 307	280	274
Turkey	r 1,478	1,420	e 1,415
Oceania:			
Australia	5,485	4,856	5,061
New Zealand	7	e 7	e 7
Total metallurgical coke	r 386,308	372,979	374,593
GASHOUSE COKE [8]			
South America:			
Brazil	r 206	90	49
Uruguay	r 19	17	15
Europe:			
Czechoslovakia	29	13	e 13
Denmark	202	149	e 125
France	11	4	e 4
Greece	17	15	e 13
Germany, West	2,827	2,220	1,894
Hungary	440	417	e 400
Ireland [3]	40	--	NA
Italy	138	125	51
Poland	1,475	1,466	e 1,450
Spain	10	8	5
Sweden	405	409	e 400
Switzerland	182	115	100
United Kingdom	2,589	1,056	251
Africa:			
South Africa, Republic of	e 110	111	e 112
Asia:			
India	r 81	88	e 88
Japan	r 5,671	5,283	4,873
Taiwan	10	9	1
Turkey e	200	200	200
Sri Lanka (formerly Ceylon)	--	9	8
Oceania:			
Australia e	772	772	772
New Zealand [9]	39	e 40	e 40
Total gashouse coke	r 15,473	12,616	10,864
ALL OTHER TYPES [10]			
Europe:			
Czechoslovakia e	1,540	1,540	1,540
Germany, East [11]	6,918	e 6,600	e 6,600
Hungary	e 90	NA	NA
Asia:			
India	r 4,314	3,852	e 3,843
Turkey e	80	80	80
Total all other types	r 12,942	12,072	12,063
Grand total	r 414,723	397,667	397,520

e Estimate. p Preliminary. r Revised. NA Not available.

[1] In addition to the countries listed, Algeria, Arab Republic of Egypt, Malaysia, 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 into the time period covered by this table, but no statistics are available and information is inadequate to make reliable estimates of output levels. Japan also produces low temperature coke but data are not available except where otherwise noted, coke breeze has been excluded from this table.

[2] Coke produced at high temperature in conventional carbonizing equipment (including slot and beehive coke ovens).

[3] Includes beeeze.

[4] Includes relatively small amounts of gas coke.

[5] Includes relatively small amounts of low-temperature coke.

[6] Data are total of so-called hard coke production from collieries and coke plants (including those at steelworks).

[7] Data are for years beginning March 21 of that stated.

[8] Includes coke produced at high temperatures in carbonizing equipment designed primarily for gas manufacture. (Horizontal and vertical coal-gas retorts.) In addition to countries listed, Canada and Finland produce gas coke but output is not reported separately from metallurgical coke and the output has been included in that section of this table.

[9] Data are for years beginning March 31 of that stated.

[10] Includes coke produced at low and medium temperatures, as well as produced in unconventional equipment (chain-grate cokers).

[11] Includes coke produced from lignite at high temperatures.

Table 22.—Quantity and value at ovens of coal carbonized in the United States in 1972, by State

State	Coal carbonized: Thousand short tons	Coal carbonized: Value: Total (thousands)	Coal carbonized: Value: Average	Coal per ton of coke: Short tons	Coal per ton of coke: Value
OVEN COKE					
Alabama	7,551	$106,899	$14.16	1.42	$20.11
California, Colorado, Utah	4,665	64,491	13.82	1.59	21.97
Illinois	3,312	49,474	14.94	1.59	23.75
Indiana	13,788	216,898	15.73	1.50	23.60
Kentucky, Missouri, Tennessee, Texas	2,984	45,599	15.28	1.42	21.70
Maryland and New York	7,817	160,374	20.52	1.44	29.55
Michigan	4,992	96,757	19.38	1.36	26.36
Minnesota and Wisconsin	1,138	20,666	18.16	1.39	25.24
Ohio	12,725	197,107	15.49	1.44	22.31
Pennsylvania	22,886	340,483	14.88	1.44	21.43
West Virginia	4,828	65,197	13.50	1.38	18.63
Total 1972 [1]	86,687	1,363,945	15.74	1.45	22.81
At merchant plants	7,793	137,701	17.67	1.39	24.56
At furnace plants	78,893	1,226,244	15.54	1.45	22.53
Total 1971	81,952	1,146,959	14.00	1.45	20.30
BEEHIVE COKE					
Pennsylvania and Virginia	1,059	10,428	9.85	1.62	15.96
Total:					
1972	1,059	10,428	9.85	1.62	15.96
1971	1,289	11,005	8.54	1.67	14.26

[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	1971: Slot	1971: Beehive	1971: Total	1972: Slot	1972: Beehive	1972: Total
January	8,169	107	8,276	6,790	82	6,872
February	7,298	120	7,418	6,689	86	6,775
March	8,255	125	8,380	7,373	85	7,458
April	8,047	110	8,157	7,338	85	7,423
May	8,182	125	8,307	7,557	82	7,639
June	7,615	126	7,741	7,126	84	7,210
July	6,896	110	7,006	7,276	79	7,355
August	5,067	97	5,164	7,273	87	7,360
September	5,722	95	5,817	6,952	88	7,040
October	5,633	90	5,723	7,258	87	7,345
November	4,597	82	4,679	7,063	102	7,165
December	6,051	101	6,152	7,518	112	7,630
Total [1]	81,531	1,289	82,820	86,213	1,059	87,272

[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

(Thousand short tons)

Month	1971	1972
January	35	40
February	28	42
March	36	42
April	38	38
May	37	37
June	36	41
July	33	36
August	37	37
September	37	38
October	38	40
November	27	41
December	39	42
Total	421	474

Table 25.—Average value per short ton of coal carbonized at oven-coke plants in the United States, by State

State	1971	1972
Alabama	$12.46	$14.16
California, Colorado, Utah	12.50	13.82
Illinois	13.41	14.94
Indiana	14.67	15.73
Kentucky, Missouri, Tennessee, Texas	11.73	15.28
Maryland, New Jersey, New York	18.94	[1] 20.52
Michigan	17.71	19.38
Minnesota and Wisconsin	18.99	18.16
Ohio	13.52	15.49
Pennsylvania	12.37	14.88
West Virginia	12.52	13.50
Average	14.00	15.73
Value of coal per ton of coke	20.30	22.81

[1] Does not include New Jersey.

Table 26.—Average volatile content of bituminous coal carbonized by oven-coke plants in the United States

(Thousand short tons)

Year	High		Medium		Low		Total	
	Quantity	Volatile content (%)	Quantity	Volatile content (%)	Quantity	Volatile content (%)	Quantity	Volatile content (%)
1968	55,853	35.0	12,906	27.3	20,074	18.7	88,833	30.2
1969	59,284	35.1	12,785	26.8	19,674	18.6	91,743	30.4
1970	62,703	34.0	11,660	26.3	20,217	17.2	[1] 94,581	29.4
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

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

Table 27.—Coal received by oven-coke plants in the United States in 1972, by consuming State and volatile content [1]

(Thousand short tons)

Consuming State	High-volatile		Medium-volatile		Low-volatile		Total coal receipts
	Quantity	% of total	Quantity	% of total	Quantity	% of total	
Alabama	1,664	20.2	5,703	69.4	853	10.4	8,220
California, Colorado, Utah	3,858	84.0	651	14.2	81	1.8	4,591
Illinois	2,646	80.9	71	2.1	555	17.0	3,271
Indiana	8,966	64.5	1,905	13.7	3,030	21.8	13,900
Kentucky, Missouri, Tennessee, Texas	1,691	56.5	412	13.9	884	29.6	2,989
Maryland and New York	5,454	70.7	1,119	14.5	1,143	14.8	7,715
Michigan	3,480	65.3	209	3.9	1,638	30.8	5,328
Minnesota and Wisconsin	394	36.7	240	22.3	440	41.0	1,074
Ohio	10,092	78.4	385	3.0	2,397	18.6	12,874
Pennsylvania	15,662	68.0	3,772	16.4	3,584	15.6	23,018
West Virginia	4,089	82.1	--	--	893	17.9	4,981
Total 1972 [2]	57,997	65.9	14,468	16.5	15,497	17.6	87,962
At merchant plants	3,190	40.9	1,446	18.5	3,168	40.6	7,804
At furnace plants	54,807	68.4	13,022	16.2	12,330	15.4	80,158
Total 1971	52,345	65.9	12,611	15.9	14,440	18.2	79,397

[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 1972, by producing county and volatile content [1]

(Thousand short tons)

State and county of production	Volatile content			Total [2]
	High	Medium	Low	
Alabama:				
Bibb	310	--	--	310
Jefferson	688	5,532	--	6,220
Tuscaloosa	--	100	--	100
Walker	40	87	--	127
Arkansas:				
Sebastian	--	--	115	115
Colorado:				
Gunnison	450	--	--	450
Las Animas	616	--	--	616
Moffat	296	--	--	296
Pitkin	--	651	--	651
Illinois:				
Franklin	1,321	--	--	1,321
Jefferson	2,251	--	--	2,251
Saline	125	--	--	125
Kentucky:				
Boyd	212	--	--	212
Estill	50	--	--	50
Floyd	1,962	--	--	1,962
Harlan	4,440	--	--	4,440
Knott	360	--	--	360
Knox	147	--	--	147
Letcher	2,837	--	--	2,837
Pike	3,473	--	--	3,473
New Mexico:				
Colfax	625	--	--	625
Oklahoma:				
Haskell	1	219	48	268
Le Flore	--	--	17	17
Rogers	164	--	--	164
Pennsylvania:				
Anthracite	--	--	388	388
Bituminous:				
Allegheny	1,872	--	--	1,872
Blair	--	--	5	5
Cambria	--	949	2,254	3,204
Clearfield	--	--	16	16
Greene	4,835	--	--	4,835
Somerset	--	79	758	838
Washington	11,238	--	--	11,238
Westmoreland	1,432	--	--	1,432
Utah:				
Carbon	1,872	--	--	1,872
Virginia:				
Buchanan	910	417	1,055	2,382
Dickenson	683	([3])	--	683
Russell	200	678	--	877
Tazewell	--	6	--	6
Wise	171	--	--	171
West Virginia:				
Barbour	267	--	--	267
Boone	1,879	--	--	1,879
Fayette	1,997	376	873	3,246
Gilmer	10	--	--	10
Greenbrier	--	171	--	171
Harrison	--	10	--	10
Kanawha	2,233	--	--	2,233
Logan	4,663	423	--	5,087
McDowell	55	3,542	5,264	8,863
Marion	1,043	--	--	1,043
Mercer	--	1	894	895
Mingo	1,604	44	--	1,648
Monongalia	280	--	--	280
Nicholas	190	648	--	838
Preston	--	--	--	--
Raleigh	--	15	1,437	1,452
Upshur	--	--	--	--
Wayne	18	--	--	18
Webster	--	52	--	52
Wyoming	180	467	2,373	3,021
Total [2]	57,997	14,468	15,497	87,962

[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.
[3] Less than ½ unit.

Table 29.—Origin of coal received by oven-coke plants in the United States in 1972, by State

(Thousand short tons)

Consuming State	Producing State						
	Alabama	Arkansas	Colorado	Illinois	Kentucky	New Mexico	Oklahoma
Alabama	6,438	--	--	--	--	--	--
California, Colorado, Utah	--	--	2,013	--	--	625	--
Illinois	--	105	--	1,242	1,138	--	(1)
Indiana	320	--	--	2,455	3,123	--	1
Kentucky, Missouri, Tennessee, Texas	(1)	--	--	--	620	--	416
Maryland and New York	--	--	--	--	2,091	--	--
Michigan	--	10	--	--	1,811	--	30
Minnesota and Wisconsin	--	--	--	--	263	--	--
Ohio	--	--	--	--	1,912	--	--
Pennsylvania	--	--	--	--	2,292	--	--
West Virginia	--	--	--	--	230	--	--
Total 1972	6,758	115	2,013	3,697	13,480	625	447
At merchant plants	763	--	--	--	749	--	18
At furnace plants	5,995	115	2,013	3,697	12,732	625	429
Total 1971	5,636	26	2,536	3,839	11,521	621	486

Consuming State	Producing State—Continued					
	Pennsylvania	Utah	Virginia	Tennessee	West Virginia	Total
Alabama	51	--	917	--	814	8,220
California, Colorado, Utah	--	1,872	--	--	81	4,591
Illinois	63	--	7	--	716	3,271
Indiana	1,235	--	650	--	6,116	13,900
Kentucky, Missouri, Tennessee, Texas	82	--	239	--	1,631	2,989
Maryland and New York	3,038	--	398	--	2,189	7,715
Michigan	248	--	206	--	3,022	5,328
Minnesota and Wisconsin	71	--	215	--	525	1,074
Ohio	4,364	--	697	--	5,901	12,874
Pennsylvania	11,904	--	752	--	8,070	23,018
West Virginia	2,770	--	37	--	1,944	4,981
Total 1972	23,826	1,872	4,118	--	31,009	[2] 87,962
At merchant plants	357	--	1,069	--	4,849	7,804
At furnace plants	23,469	1,872	3,049	--	26,160	80,158
Total 1971	22,955	1,468	4,440	10	25,858	79,397

[1] Less than ½ unit.
[2] Data may not add to totals shown because of independent rounding.

Table 30.—Quantity and percentage of captive coal received by oven-coke plants in the United States

(Thousand short tons)

Year	At merchant plants			At furnace plants			Total [1]		
	Total coal received	Captive coal: Quantity	Captive coal: %	Total coal received	Captive coal: Quantity	Captive coal: %	Total coal received	Captive coal: Quantity	Captive coal: %
1968	7,735	2,659	34.4	81,213	48,999	60.3	88,948	51,658	58.1
1969	8,232	2,895	35.2	83,416	52,447	62.9	91,648	55,342	60.4
1970	7,866	2,320	29.5	86,869	51,379	59.2	94,735	53,699	56.7
1971	5,284	2,235	42.3	74,113	44,319	59.8	79,397	46,554	58.6
1972	7,804	2,325	29.8	80,158	45,354	56.7	87,962	47,679	54.3

[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	1971	1972
January	8,389	7,850
February	8,327	8,118
March	8,966	8,560
April	9,804	9,343
May	10,642	10,014
June	10,849	10,138
July	8,517	8,259
August	10,369	8,558
September	11,818	8,777
October	7,988	9,052
November	5,381	9,460
December	7,199	9,032

Table 32.—Month-end stocks of anthracite at oven-coke plants in the United States

(Thousand short tons)

Month	1971	1972
January	111	107
February	97	125
March	80	79
April	65	68
May	55	66
June	70	61
July	89	60
August	102	68
September	108	70
October	110	90
November	130	96
December	118	84

Table 33.—Coal-chemical materials, exclusive of breeze, produced at oven-coke plants in the United States in 1972 [1]

Product	Produced	Sold: Quantity (thousands)	Sold: Value: Total (thousands)	Sold: Value: Average per unit	On hand Dec. 31
Tar, crude ... thousand gallons	747,186	340,875	$39,634	$0.116	51,436
Tar derivatives:					
Sodium phenolate or carbolate ... do	3,007	2,837	211	.074	178
Crude chemical oil (tar acid oil) ... do	9,731	9,722	1,469	.151	122
Pitch of tar: [2]					
Soft ... thousand short tons	326	137	5,149	37.584	7
Hard ... do	209	97	4,109	42.361	4
Other tar derivatives [3]	--	--	12,469	--	--
Ammonia products:					
Sulfate ... thousand short tons	564	471	7,588	16.110	83
Liquor (NH_3 content) ... do	13	13	614	47.231	2
Diammonium phosphate ... do	41	39	4,120	105.641	2
Total ... do	--	--	12,322	--	--
Sulfate equivalent of all forms ... do	656	559	--	--	92
NH_3 equivalent of all forms ... do	169	144	--	--	24
Gas:					
Used under boilers, etc ... million cubic feet	--	102,360	27,241	.266	--
Used in steel or allied plants ... do	--	364,896	101,307	.278	--
Distributed through city mains ... do	[4] 916,011	11,392	3,947	.347	--
Sold for industrial use ... do	--	55,843	11,397	.204	--
Total ... do	[4] 916,011	534,491	[5] 143,893	.269	--
Crude light oil ... thousand gallons	[6] 214,201	86,915	9,584	.110	10,151
Light oil derivatives:					
Benzene:					
Specification grades (1°, 2°, 90%) ... do	76,317	76,739	15,847	.207	2,507
Other industrial grades ... do	3,532	3,486	491	.141	67
Toluene (all grades) ... do	14,571	13,954	2,501	.179	810
Xylene (all grades) ... do	3,351	3,208	578	.180	517
Solvent naphtha (all grades) ... do	2,815	2,596	462	.178	242
Other light oil derivatives ... do	3,898	2,520	849	.337	335
Total ... do	104,484	102,503	20,728	.202	4,478
Intermediate light oil ... do	3,704	754	70	.093	214
Grand total	--	--	[5] 249,638	--	--

[1] Includes products of tar distillation conducted by oven-coke operators under the same corporate names.
[2] Soft-water-softening point—less than 110° F; medium—110° to 160° F; hard-oven—160° F. Figures on hard pitch includes small amount of medium pitch.
[3] Creosote oil, cresols, cresylic acid, naphthalene, phenol, pyridine, refined tar, tar paint.
[4] Includes gas used for heating ovens and gas wasted.
[5] Data may not add to total shown because of independent rounding.
[6] 119,485,000 gallons refined by coke-oven operators to make derived products shown.

Table 34.—Coal equivalent of the thermal materials, except coke, produced at oven-coke plants in the United States

Year	Materials produced				Estimated equivalent in heating value [1] (billion Btu)					Coal equivalent (thousand short tons)
	Coke breeze (thousand short tons)	Surplus gas (billion cubic feet)	Tar (thousand gallons)	Light oil (thousand gallons)	Coke breeze	Surplus gas	Tar	Light oil	Total	
1968	4,074	575	760,812	238,887	81,480	316,250	114,114	31,055	542,899	20,721
1969	4,401	595	768,766	258,910	88,020	327,250	115,315	33,658	564,243	21,536
1970	4,665	585	760,926	244,107	93,300	321,750	114,139	31,734	560,923	r 21,409
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	19,740

[1] Breeze, 10,000 Btu per pound; gas, 550 Btu per cubic foot; tar, 150,000 Btu per gallon; and light oil, 130,000 Btu per gallon.

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

	1968	1969	1970	1971	1972
Ammonia products	$0.194	$0.173	$0.151	$0.136	$0.142
Light oil and its derivatives	.427	.435	.405	.365	.350
Surplus gas used or sold	1.483	1.502	1.561	1.640	1.660
Tar and its derivatives (including naphthalene):					
Tar burned by producers [1]	.311	.317	.398	.341	.366
Sold	.727	.685	.623	.721	.727
Total	3.142	3.112	3.138	3.203	3.245
Coke produced	12.246	[2] 12.560	[2] 19.208	[2] 21.135	[2] 22.978
Breeze produced	.314	.388	.481	.534	.533
Grand total	15.702	16.060	22.827	24.872	26.754

[1] Includes pitch-of-tar.
[2] 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

	1968	1969	1970	1971	1972
Product:					
Ammonia products	1.9	1.8	1.3	1.1	1.0
Light oil and its derivatives	4.3	4.4	4.3	3.8	3.2
Surplus gas used or sold	15.1	14.4	12.8	11.7	10.6
Tar and its derivatives used or sold (including naphthalene)	10.4	10.5	9.0	8.0	8.0
Total	31.7	31.1	27.4	24.6	22.8
Value of coal per short ton	$10.01	$10.42	$12.21	$14.00	$15.74

Table 37.—Production and disposal of coke-oven gas in the United States in 1972, 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	72,836	9.65	34,467	35,924	$8,285	$0.231	2,446
California, Colorado, Utah	61,498	13.18	19,339	42,002	9,489	.226	157
Illinois	33,524	10.12	13,948	16,908	4,178	.247	2,668
Indiana	147,257	10.68	56,939	89,341	21,936	.246	977
Kentucky, Missouri, Tennessee, Texas	25,408	8.51	12,346	10,471	2,482	.237	2,590
Maryland and New York	85,317	10.91	32,707	50,367	17,368	.345	2,244
Michigan	50,581	10.13	14,200	33,005	9,310	.363	3,376
Minnesota and Wisconsin	9,793	8.61	4,009	5,485	1,393	.254	300
Ohio	131,999	10.37	52,910	75,730	22,762	.301	3,359
Pennsylvania	244,185	10.67	105,214	137,517	36,415	.265	1,453
West Virginia	53,611	11.10	15,808	37,740	10,275	.272	63
Total 1972 [1]	916,011	10.57	361,887	534,491	143,893	.269	19,632
At merchant plants	69,221	8.88	32,016	29,217	7,130	.244	6,988
At furnace plants	846,790	10.73	329,871	505,274	136,763	.271	12,644
Total 1971	861,691	10.51	335,978	506,563	134,382	.265	19,150

[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 1972, by State

(Million cubic feet)

State	Used by producers					
	Under boilers, etc.			In steel or allied plants		
	Quantity	Value: Thousands	Value: Average per thousand cubic feet	Quantity	Value: Thousands	Value: Average per thousand cubic feet
Alabama	15,015	$3,584	$0.239	16,734	$3,854	$0.231
California, Colorado, Utah	(1)	(1)	(1)	(1)	(1)	(1)
Illinois	4,424	1,186	.268	11,603	2,813	.242
Indiana	16,023	4,615	.288	70,062	15,972	.228
Kentucky, Missouri, Tennessee, Texas	6,131	1,600	.261	(1)	(1)	(1)
Maryland and New York	822	159	.193	43,277	14,918	.345
Michigan	(1)	(1)	(1)	(1)	(1)	(1)
Minnesota and Wisconsin	3,483	909	.261	(1)	(1)	(1)
Ohio	9,578	3,073	.321	61,196	18,586	.304
Pennsylvania	14,027	3,699	.264	81,865	24,370	.298
West Virginia	(1)	(1)	(1)	(1)	(1)	(1)
Undistributed	32,858	8,416	.256	80,160	20,793	.259
Total 1972 [2]	102,360	27,241	.266	364,896	101,307	.278
At merchant plants	11,016	2,579	.234	(3)	(3)	(3)
At furnace plants	91,344	24,662	.270	364,896	101,307	.278
Total 1971	100,816	26,016	.258	339,299	93,630	.276

State	Sold					
	Distributed through city mains			For industrial use		
	Quantity	Value: Thousands	Value: Average per thousand cubic feet	Quantity	Value: Thousands	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)	(1)	(1)	(1)
Maryland and New York	(1)	(1)	(1)	(1)	(1)	(1)
Michigan	(1)	(1)	(1)	(1)	(1)	(1)
Minnesota and Wisconsin	(1)	(1)	(1)	(1)	(1)	(1)
Ohio	(1)	(1)	(1)	(1)	(1)	(1)
Pennsylvania	(1)	(1)	(1)	(1)	(1)	(1)
West Virginia	--	--	--	(1)	(1)	(1)
Undistributed	11,392	$3,947	$0.347	55,843	$11,397	$0.204
Total 1972 [2]	11,392	3,947	.347	55,843	11,397	.204
At merchant plants	11,392	3,947	.347	13,109	2,781	.212
At furnace plants	(4)	(4)	(4)	42,734	8,616	.202
Total 1971	10,795	3,554	.329	55,653	11,182	.201

[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.
[4] Included with merchant plants to avoid disclosing individual company confidential data.

Table 39.—Coke-oven gas and other gases in heating coke ovens in the United States in 1972, by State [1]

(Million cubic feet)

State	Coke-oven gas	Blast-furnace gas	Natural gas	Total coke-oven gas equivalent
Alabama	34,467	--	--	34,467
California, Colorado, Utah	19,339	--	43	19,382
Illinois	13,948	1,682	--	15,630
Indiana	56,939	4,343	2,931	64,213
Kentucky, Missouri, Tennessee, Texas	12,346	--	--	12,346
Maryland and New York	32,707	7,160	317	40,184
Michigan	14,200	8,739	--	22,939
Minnesota and Wisconsin	4,009	--	32	4,041
Ohio	52,910	558	--	53,468
Pennsylvania	105,214	2,135	--	107,349
West Virginia	15,808	6,760	--	22,568
Total 1972 [2]	361,887	31,377	3,322	396,586
At merchant plants	32,016	--	32	32,048
At furnace plants	329,871	31,377	3,290	364,538
Total 1971	335,978	31,947	2,985	370,910

[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 1972, 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	67	17.82	67	--
California, Colorado, Utah	3	67	28.77	44	(3)
Illinois	4	22	13.28	22	--
Indiana and Michigan	6	152	19.26	145	(3)
Kentucky, Minnesota, Tennessee, Texas	4	17	15.74	9	(3)
Maryland and New York	4	76	19.65	73	(3)
Ohio	11	101	16.71	91	(3)
Pennsylvania	9	112	18.40	112	--
West Virginia	3	41	17.11	41	--
Undistributed	--	--	--	--	13
Total 1972 [4]	51	656	18.93	[5] 604	13
At merchant plants	7	35	23.89	(6)	13
At furnace plants	44	621	18.71	604	(7)
Total 1971	52	632	16.21	578	14

State	Sold: As sulfate: Quantity	Sold: As sulfate: Value	Sold: As liquor (NH_3 content): Quantity	Sold: As liquor (NH_3 content): Value	On hand Dec. 31: As sulfate	On hand Dec. 31: As liquor (NH_3 content)
Alabama	67	933	--	--	2	--
California, Colorado, Utah	49	2,138	(3)	(3)	2	(3)
Illinois	20	303	--	--	3	--
Indiana and Michigan	100	3,731	(3)	(3)	13	(3)
Kentucky, Minnesota, Tennessee, Texas	8	97	(3)	(3)	1	(3)
Maryland and New York	65	1,332	(3)	(3)	11	(3)
Ohio	74	1,185	(3)	(3)	20	(3)
Pennsylvania	90	1,567	--	--	28	--
West Virginia	38	422	--	--	4	--
Undistributed	--	--	13	614	--	2
Total 1972 [4]	[8] 510	11,708	13	614	84	2
At merchant plants	(6)	(6)	13	614	1	2
At furnace plants	510	11,708	(7)	(7)	84	(7)
Total 1971	663	11,361	16	806	28	2

[1] Number of plants that recovered ammonia.
[2] Includes diammonium phosphate.
[3] Included with "Undistributed" to avoid disclosing individual company data.
[4] Data may not add to totals shown because of independent rounding.
[5] Comprises 564,000 tons of ammonium sulfate and 41,000 tons of diammonium phosphate.
[6] Included with furnace plants to avoid disclosing individual company data.
[7] Included with merchant plants to avoid disclosing individual company data.
[8] Comprises 471,000 tons of ammonium sulfate valued at $7,588,000 and 39,000 tons of diammonium phosphate valued at $4,120,000.

Table 41.—Coke-oven tar produced in the United States, used by producers, and sold in 1972, by State

(Thousand gallons)

State	Produced: Total	Produced: Gallons per ton of coal coked	Used by producers: For refining or topping	Used by producers: As fuel	Used by producers: Otherwise
Alabama	54,937	7.28	(1)	(1)	(1)
California, Colorado, Utah	46,864	10.05	(1)	(1)	(1)
Illinois	22,152	6.69	(1)	(1)	(1)
Indiana	147,152	10.67	(1)	31,784	(1)
Kentucky, Missouri, Tennessee, Texas	19,752	6.62	--	--	(1)
Maryland and New York	63,256	8.09	(1)	(1)	(1)
Michigan	34,202	6.85	--	--	--
Minnesota and Wisconsin	6,315	5.55	--	--	(1)
Ohio	111,826	8.79	(1)	52,686	(1)
Pennsylvania	200,236	8.75	(1)	24,986	(1)
West Virginia	40,494	8.39	(1)	(1)	(1)
Undistributed	--	--	273,388	9,574	4,286
Total 1972 [2]	747,186	8.62	273,388	119,030	4,286
At merchant plants	43,453	5.58	(3)	(3)	(3)
At furnace plants	703,733	8.92	273,388	119,030	4,286
Total 1971	679,377	8.29	230,959	111,877	1,647

State	Sold for refining into tar products: Quantity	Value: Thousands	Value: Average per gallon	On hand Dec. 31
Alabama	34,416	$3,969	$0.115	2,579
California, Colorado, Utah	30,878	4,305	.139	3,300
Illinois	21,204	2,318	.109	1,575
Indiana	28,491	3,134	.110	4,841
Kentucky, Missouri, Tennessee, Texas	19,291	2,185	.113	688
Maryland and New York	35,836	4,017	.112	8,005
Michigan	33,673	3,560	.106	2,652
Minnesota and Wisconsin	14,119	1,553	.110	2,007
Ohio	47,804	5,932	.125	6,260
Pennsylvania	75,163	8,660	.115	19,528
West Virginia	(4)	(4)	(4)	(4)
Undistributed	--	--	--	--
Total 1972 [2]	340,875	39,634	.116	51,436
At merchant plants	42,720	4,877	.114	1,725
At furnace plants	298,156	34,757	.117	49,711
Total 1971	334,076	35,960	.108	40,634

1 Included with "Undistributed" to avoid disclosing individual company data.
2 Data may not add to totals shown because of independent rounding.
3 Included with furnace plants to avoid disclosing individual company data.
4 Included with Minnesota and Wisconsin to avoid disclosing individual company data.

Table 42.—Coke-oven crude light oil produced in the United States and derived products produced and sold in 1972, by State

(Thousand gallons)

State	Active plants[1]	Crude light oil: Produced	Crude light oil: Gallons per ton of coal	Crude light oil: Refined on premises[2]	Crude light oil: On hand Dec. 31	Derived products: Produced	Derived products: Sold[3]: Quantity	Derived products: Sold[3]: Value (thousands)
Alabama	7	14,841	1.98	5,783	1,941	3,299	3,190	$568
California, Colorado, Utah	3	16,793	3.60	11,100	347	8,886	7,769	1,638
Illinois, Indiana, Michigan	10	41,940	2.26	454	1,692	(4)	(4)	(4)
Kentucky, Missouri, Tennessee, Texas, West Virginia	7	19,002	2.56	1,886	1,146	1,912	1,899	394
Maryland and New York	4	22,942	2.96	11,114	1,058	9,856	9,575	1,924
Ohio	11	32,134	2.58	19,570	881	17,229	17,567	2,860
Pennsylvania	10	66,548	3.01	69,578	3,086	63,304	62,502	13,343
Total 1972 [5]	52	214,201	2.66	119,485	10,151	104,484	102,502	20,727
At merchant plants	6	9,026	1.98	379	857	(6)	(6)	(6)
At furnace plants	46	205,175	2.70	119,106	9,294	104,484	102,502	20,727
Total 1971	56	201,626	2.57	110,301	8,472	94,625	94,076	18,338

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 86,915,000 gallons of crude light oil valued at $9,584,000 sold as such.
4 Included with Maryland and New York to avoid disclosing individual company confidential data.
5 Data may not add to totals shown because of independent rounding.
6 Included with furnace plants to avoid disclosing individual company confidential data.

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
1968	63.9	13.6	3.8	2.6	4.6
1969	67.0	13.1	3.5	2.9	4.4
1970	63.0	12.1	3.2	3.3	5.2
1971	65.6	12.4	2.8	3.2	5.0
1972	59.3	12.8	3.1	3.0	4.7

Table 44.—Benzene and toluene produced at oven-coke plants in the United States, by grade

(Thousand gallons)

Year	Benzene: Specification grades (1°, 2°, 90 %)	Benzene: Other industrial grades	Toluene (all grades)
1968	88,449	4,136	19,645
1969	97,503	4,192	19,603
1970	89,517	3,975	17,401
1971	68,756	3,391	13,345
1972	76,317	3,532	14,571

Table 45.—Light oil derivatives produced at oven-coke plants in the United States and sold in 1972, by State

(Thousand gallons and thousand dollars)

State	Benzene (all grades)				Toluene (all grades)			
	Produced	Yield from crude light oil refined (%)	Sold: Quantity	Sold: Value	Produced	Yield from crude light oil refined (%)	Sold: Quantity	Sold: Value
Alabama	2,254	47.4	2,127	394	557	14.4	581	92
Colorado, Indiana, Utah	6,409	55.9	6,368	1,357	1,558	13.6	[1] 770	[1] 135
Maryland, Tennessee, Texas	10,403	74.4	10,143	2,029	532	5.4	505	92
Ohio	13,298	66.4	13,561	2,169	2,696	13.8	2,773	476
Pennsylvania	47,485	55.8	48,025	10,390	9,227	8.4	9,326	1,706
Total 1972 [2 3]	79,850	59.3	80,225	16,338	14,571	12.8	13,954	2,501
Total 1971	72,147	65.6	73,145	14,493	13,345	12.4	13,265	2,300

State	Xylene (all grades)				Solvent naphtha (crude and refined)			
	Produced	Yield from crude light oil refined (%)	Sold: Quantity	Sold: Value	Produced	Yield from crude light oil refined (%)	Sold: Quantity	Sold: Value
Alabama	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Colorado, Indiana, Utah	324	3.0	268	50	406	3.5	203	34
Maryland, Tennessee, Texas	184	1.4	150	28	187	4.3	198	24
Ohio	662	4.0	674	125	(5)	(5)	(5)	(5)
Pennsylvania	2,181	3.2	2,117	375	2,222	2.9	2,195	404
Total 1972 [2 3]	3,351	3.1	3,208	578	2,815	3.0	2,596	462
Total 1971	2,906	2.8	2,724	513	2,875	3.2	2,472	359

[1] Includes Illinois to avoid disclosing individual company confidential data.
[2] Data may not add to totals shown because of independent rounding.
[3] Data not broken down into merchant and furnace plants to avoid disclosing individual company confidential data.
[4] Included with Maryland, Tennessee, and Texas to avoid disclosing individual company confidential data.
[5] Included with Pennsylvania to avoid disclosing individual company confidential data.

Columbium and Tantalum

By Joseph A. Sutton [1]

The 1972 demand for columbium and tantalum in steelmaking continued an upward trend that began in 1968. For steelmaking purposes consumption of ferrocolumbium (FeCb), ferrotantalum-columbium (FeTa–Cb), and other columbium and tantalum materials totaled 2.9 million pounds in 1972. The primary use of these materials was for the production of high strength-low alloy steels. During the year while imports of columbium mineral concentrates and the price of columbium raw materials in the forms of columbite and pyrochlore concentrates were increasing, approximately 2.3 million pounds of combined pentoxides were awarded to industry from Government stocks. The primary use of tantalum continued to be for capacitors in the electronics industry. The chemical industry for the first time used large sheets of thin-gage tantalum to make pressure vessels that were to be used in the Kel-Chlor process for recovering chlorine from byproduct hydrogen chloride.

Legislation and Government Programs.—During 1972 the Office of Minerals Exploration (OME), U.S. Geological Survey, continued to offer financial assistance of 50% (columbium) and 75% (tantalum) of costs for exploration of approved columbium and tantalum resources.

The General Services Administration (GSA) continued its columbium disposal program and sold to industry 1,857,382 pounds of columbium and 380,209 pounds

[1] Physical scientist, Division of Ferrous Metals.

Table 1.—Salient columbium statistics

(Thousand pounds)

	1968	1969	1970	1971	1972
United States:					
Mine production of columbite-tantalite concentrates	W	W	[1] --	[1] --	--
Releases from Government stocks (Cb content) [2] [3]	r 1,505	r 1,810	r 1,042	36	779
Consumption of concentrate: Columbium metal contained in all raw materials consumed (Cb content)[2]	3,997	2,918	3,289	2,346	2,489
Production of primary products:					
Columbium metal (Cb content)	W	W	W	W	W
Ferrocolumbium and ferrotantalum-columbium (Cb+Ta content)	2,380	2,554	1,430	1,020	1,480
Consumption of primary products:					
Columbium metal (Cb content)	92	179	261	459	218
Ferrocolumbium and ferrotantalum-columbium (Cb+Ta content)	3,094	3,328	2,591	2,880	3,676
Exports: Columbium metal, compounds, and alloys (gross weight)	7	41	46	21	29
Imports for consumption:					
Columbium mineral concentrate (gross weight)	3,657	4,161	5,719	3,054	3,227
Columbium metal and columbium-bearing alloys (Cb content)	1	5	2	1	1
Ferrocolumbium (gross weight)e	1,171	NA	NA	NA	NA
Tin slags (Cb content) [4]	378	454	498	526	547
World: Production of columbium-tantalum concentrates (gross weight)	23,857	31,451	45,149	24,014	34,953

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

[1] Revised to none.

[2] Includes columbium content in raw materials from which columbium is not recovered.

[3] Includes material released as payment-in-kind for upgrading.

[4] Receipts reported by consumers.

of tantalum in the forms of columbium ores and concentrates, 282,370 pounds of columbium in the form of ferrocolumbium and 14,289 pounds of columbium in the form of columbium oxide powder. Of the quantities of columbium and tantalum awarded in the forms of columbium ores and concentrates, 498,366 pounds of columbium and 70,348 pounds of tantalum were sold on a negotiated bid basis at a value of $708,833 in payment for other commodities furnished to GSA. The value of all sales of columbium-bearing materials in 1972 was $4,076,054. The quantities of columbium and tantalum materials reported in Government inventories as of December 31, 1972, are listed on table 3.

Table 2.—Salient tantalum statistics

(Thousand pounds)

	1968	1969	1970	1971	1972
United States:					
Mine production of columbium-tantalum concentrates	W	W	[1] --	[1] --	--
Releases from Government stocks (Ta content) [2] [3]	r 476	r 215	r 161	6	87
Consumption of concentrate: Tantalum metal contained in all raw materials consumed (Ta content) [2]	1,060	928	1,733	1,116	1,280
Production of primary products:					
Tantalum metal (Ta content)	692	1,046	916	892	1,352
Ferrocolumbium and ferrotantalum-columbium (Cb+ Ta content)	2,380	2,554	1,430	1,020	1,480
Consumption of primary products:					
Tantalum metal (Ta content)	423	751	417	649	922
Ferrocolumbium and ferrotantalum-columbium (Cb+ Ta content)	3,094	3,328	2,591	2,880	3,676
Exports:					
Tantalum ore and concentrate (gross weight)	65	85	122	48	195
Tantalum metal, compounds, and alloys (gross weight)	106	124	640	194	146
Tantalum and tantalum alloy powder (Ta content)	84	100	139	85	171
Imports for consumption:					
Tantalum mineral concentrates (gross weight)	1,230	975	1,046	1,180	1,229
Tantalum metal and tantalum-bearing alloys (Ta content)	18	11	51	40	74
Tin slags (Ta content) [4]	418	371	470	481	625
World: Production of columbium-tantalum concentrates (gross weight)	23,857	31,451	45,149	24,014	34,953

r Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Revised to none.
[2] Includes tantalum content in raw materials from which tantalum is not recovered.
[3] Includes material released as payment-in-kind for upgrading.
[4] Receipts reported by consumers.

Table 3.—Columbium and tantalum materials in Government inventories, as of Dec. 31, 1972

(Thousand pounds, columbium and tantalum content)

Material	Objective	National (strategic) stockpile	Defense Production Act (DPA) inventory	Supplemental stockpile	Total
COLUMBIUM					
Concentrate	--	5,336	1,307	241	6,884
Carbide powder: Stockpile grade	20	21	--	--	21
Ferrocolumbium:					
Stockpile grade	930	650	--	--	650
Nonstockpile grade	--	738	--	--	738
Metal: Stockpile grade	45	45	--	--	45
Oxide powder: Stockpile grade	--	86	--	--	86
TANTALUM					
Tantalum minerals: Stockpile grade	2,947	3,065	756	3	3,824
Carbide powder: Stockpile grade	27	29	--	--	29
Metal: Stockpile grade	360	201	--	--	201

DOMESTIC PRODUCTION

Domestic mining activity was insignificant during the year. One company produced a few pounds of columbium and tantalum while doing exploration and development work in Larimer County, Colo., but none of the material was marketed.

Production of columbium metal powder decreased 43% in 1972, but data continued to be withheld to avoid disclosing individual company confidential data. Production of columbium metal ingot decreased 64%, but again specific information was withheld. Production of tantalum metal powder (including capacitor-grade powder) increased 51% to 676 tons in 1972; production of tantalum metal ingot increased 52% to 257 tons.

Ferrocolumbium and columbium master alloys were produced by the thermite process by the Reading Alloys, Co., Inc., and Shieldalloy Corp. Foote Mineral Co., Kawecki Division of Kawecki Berylco Industries, Inc., and Union Carbide Corp. produced the material in electric furnaces. During the last 3 years no production of ferrotantalum-columbium has been reported by the industry.

Table 4.—Major domestic columbium and tantalum processing and producing companies in 1972

Company	Location	Columbium	Tantalum	Tantalum carbide	Ferrocolumbium
Allegheny-Ludlum Industries, Inc	Brackenbridge, Pa; Watervliet, N.Y	X	--	--	--
Fansteel Inc	Chicago, Ill; Muskogee, Okla	X	X	X	--
Kawecki Division, Kawecki Berylco Industries, Inc.	Boyertown, Pa	X	X	X	X
Kennametal, Inc	Latrobe, Pa	X	X	X	--
Mallinckrodt Chemical Works	St. Louis, Mo	X	X	--	--
Mining and Metals Division, Union Carbide Corp.	Niagara Falls, N.Y; Marietta, Ohio; Greenville, S.C	X	X	--	X
Metals Division, Norton Co	Newton, Mass	X	X	--	--
Newcomer Products, Inc	Latrobe, Pa	X	X	--	--
Reading Alloys, Co., Inc	Robesonia, Pa	X	--	--	X
Shieldalloy Corp	Newfield, N.J	X	--	--	X
Metallurgical Products Division, Foote Mineral Co.	Cambridge, Ohio	X	--	--	X
Wah Chang Albany (A Teledyne Company)	Albany, Oreg	X	X	X	--

CONSUMPTION AND USES

Consumption of columbium in the form of high-purity metal totaled 217,562 pounds, a decrease of 47% from the total for 1971. Tantalum metal (including capacitor-grade powder) consumed during the year increased 42% and totaled 921,851 pounds. Tantalum metal continued to be used primarily in powder or ingot form in the manufacture of capacitors, other electronic equipment, and corrosion-resistant chemical equipment.

Consumption of ferrocolumbium (FeCb), ferrotantalum-columbium (FeTa–Cb), and other columbium and tantalum materials increased in all end-use categories except carbon steels. The largest single-volume increase occurred in high strength-low alloy steels. Total consumption of columbium plus tantalum increased 28% to nearly 3.7 million pounds in 1972. Domestic consumption of FeCb, FeTa–Cb, and other columbium and tantalum materials, by major end-use categories, was as follows: High strength-low alloy steel (31%), carbon steel (20%), superalloys (18%), stainless and heat-resisting steel (18%), full alloy steel (8%), miscellaneous and unspecified (4%), and alloys other than alloy steels and superalloys (1%).

The total quantity of ferrocolumbium consumed in steelmaking (excluding electric and tool steels) was approximately 2.8 million pounds, an increase of 28% over the total for 1971. Consumption of ferrotantalum-columbium continued to be small and amounted to less than 1% of the FeCb, FeTa–Cb, and other columbium and tantalum materials consumed. Stainless and heat-resisting steel continued to be the major end-use categories for FeTa–Cb.

Consumption of other tantalum and columbium materials was about 5% of the total FeCb, FeTa–Cb, and other columbium and tantalum materials consumed. Superalloys remained as the major end-use category for other tantalum and columbium materials.

American Metal Climax Inc. acquired the assets of the former General Electric Refractory Metals Center in Cleveland, Ohio. The 85,000-square-foot facility contains a variety of plate, sheet, strip, and foil rolling equipment for mill products of molybdenum, tungsten, zirconium, columbium, and tantalum, as well as superalloys.[2]

Fansteel Inc. phased out its tantalum rolling operations in Baltimore, Md., and moved them to its North Chicago, Ill., plant in an effort to improve efficiency.

The Metals Division of the Norton Co., a producer of tantalum powders and mill products, made plans to market tantalum carbide powders.[3]

IN–657, a new nickel alloy, was developed in the Birmingham research laboratory of International Nickel Co. The new nickel alloy, containing 50% chromium and 1.5% columbium, combines great strength and resistance to corrosion at high temperatures. The recent development of large sheets of thin-gage tantalum coupled with new welding techniques and explosion-bonding methods of cladding have made it possible for the chemical industry to use tantalum in large pressure vessels. Such vessels are to be used in the M. W. Kellogg Kel-Chlor process to recover chlorine from byproduct hydrogen chloride.[4]

Nickel-copper-columbium alloy steels, developed by the International Nickel Co., provided new avenues of approach in the design and fabrication of complex high structures.[5] One unique example of this occurred in the construction of mobile cranes. The use of these low-carbon nickel-containing ferritic steels made it possible to design a relatively lightweight unit that provides excellent long-reach performance for the telescopic boom section of the crane.

Single and double sling chain made entirely from Carpenter No. 20 Cb–3 stainless steel was reported to have a longer service life in sulfuric acid pickling operations than chains made from the 300 series stainless steels.[6]

[2] Metals Week. Climax Buying GE Tungsten and Molybdenum Plant. V. 43, No. 48, Nov. 27, 1972, p. 6.
[3] American Metal Market. Tantalum Carbide Powders: Norton. V. 80, No. 60, Mar. 27, 1973, p. 10.
[4] Chemical Week. New Look in Tantalum Cladding. V. 3, No. 25, Dec. 29, 1972, p. 29.
[5] American Metal Market. Nickel-Copper-Columbium Alloy Steels Providing New Designs, Structures. V. 79, No. 144, Aug. 4, 1972, p. 10.
[6] American Metal Market. Term Carpenter 20 Cb–3 Good Corrosion Fighter. V. 79, No. 214, Nov. 22, 1972, p. 9a.

Table 5.—Reported shipments of columbium and tantalum materials

(Pounds of metal content)

Material	1971	1972	% change
Columbium products:			
Compounds, including alloys	689,550	925,200	+34.2
Metal, including worked products	270,500	101,900	−62.3
All other	6,800	62,800	+823.5
Total	966,850	1,089,900	+12.7
Tantalum products:			
Oxides and salts	60,900	54,900	−9.9
Alloy additive	48,800	43,000	−11.9
Carbide	135,000	146,900	+8.8
Powder and anodes	398,700	540,700	+35.6
Ingot (unworked consolidated metal)	42,400	[1] −1,900	--
Mill products	223,300	246,400	+10.3
Scrap	52,400	58,100	+10.9
Other	--	300	--
Total	961,500	1,088,400	+13.2

[1] As reported by source.

Source: Tantalum Producers Association.

Table 6.—Consumption of ferrocolumbium, ferrotantalum-columbium, and other columbium and tantalum materials in the United States in 1972, by end use

End use	Pounds of contained columbium plus tantalum
Steel:	
Carbon	733,216
Stainless and heat resisting	644,936
Full alloy	302,740
High strength-low alloy	1,141,089
Electric	W
Tool	W
Superalloys	665,300
Alloys (excludes alloy steels and superalloys)	57,387
Miscellaneous and unspecified	131,736
Total	3,676,404

W Withheld to avoid disclosing individual company confidential data; included in "Miscellaneous and unspecified."

STOCKS

The following yearend columbium and tantalum materials (given in pounds) were reported in inventories:

Material	Dec. 31, 1971	Dec. 31, 1972
COLUMBIUM		
Primary metal	60,303	55,984
Ingot	45,324	62,826
Scrap	67,503	75,483
Oxide	1,051,357	553,800
Other compounds	[r]527,976	142,539
TANTALUM		
Primary metal	269,249	267,975
Capacitor-grade powder	163,320	154,871
Ingot	86,452	56,074
Scrap	[r]272,359	232,039
Oxide	[r]106,700	90,386
Potassium tantalum fluoride (K_2TaF_7)	[r]246,760	163,606
Other compounds	53,536	12,802

[r] Revised.

Stocks of columbium and tantalum raw materials, as reported by consumers and dealers at yearend 1972, were as follows (in short tons—1971 figures in parentheses): Columbite, 1,104 (521); tantalite, 1,120 (1,322); pyrochlore, 501 (595); tin slag, 33,775 (35,787); and other, 61 (none).

Consumers inventories of ferrocolumbium and ferrotantalum-columbium as of December 31, 1972, were as follows (with 1971 yearend stocks in parentheses): Ferrocolumbium, 814,607 pounds contained columbium (758,828); ferrotantalum-columbium, 18,592 pounds contained columbium plus tantalum (34,737); and other columbium and tantalum materials, 40,061 pounds contained columbium plus tantalum (31,818). Producer stocks of ferrocolumbium at yearend 1972 were 638,000 pounds contained columbium (534,000).

PRICES

Prices for columbite and pyrochlore, as reported by Metals Week, were higher at the end of 1972 than at the end of 1971. Columbite ore, c.i.f. U.S. ports, increased from $0.75–$0.85 per pound of contained pentoxides for material having a Cb_2O_5-to-Ta_2O_5 ratio of 10 to 1 at the beginning of the year to $1.10–$1.15 per pound at yearend. Contract rates for Canadian pyrochlore, f.o.b. mine and mill, went from $1.15–$1.20 per pound of Cb_2O_5 content to $1.37 after being down to $0.95 in the first quarter. Those for Brazilian pyrochlore similarly went from $1.15 to $1.37. Spot prices for tantalite ore, 60-percent basis, c.i.f. U.S. ports, were quoted at $6.25–$6.75 per pound Ta_2O_5 at the beginning of the year and $5.25–$6.00 per pound at yearend.

Quoted prices for various grades of ferrocolumbium were unchanged during the year: Low-alloy standard grades, ton lots, f.o.b. shipping point, $2.45–$2.65 per pound of columbium content; high-purity grades, $4.12–$6.81.

The price of columbium and tantalum metal remained unchanged during the year. Columbium powder was quoted at

$11 to $22 per pound for metallurgical-grade material, and $12 to $23 per pound for reactor-grade material. Columbium ingot was quoted at $16 to $27 per pound for metallurgical-grade material, and $17.50 to $28.00 per pound for reactor-grade material. Tantalum metal was quoted at $38.50 to $47.00 per pound for powder, $36 to $60 per pound for sheet, and $36 to $50 per pound for rod.

Table 7.—Average grade of concentrate received by U.S. consumers and dealers in 1972, by country of origin

(Contained pentoxides, %)

	Columbite		Tantalite	
	Cb_2O_5	Ta_2O_5	Ta_2O_5	Cb_2O_5
Australia	--	--	44	31
Belgium	--	--	32	40
Brazil [1] [2]	58	--	40	29
Canada [2]	58	--	51	4
Germany, West	--	--	31	28
Kenya	--	--	40	28
Malaysia [1]	66	9	11	70
Mozambique	--	--	40	30
Nigeria [1]	62	4	--	--
Portugal	--	--	36	36
Rwanda	--	--	29	41
South Africa, Republic of	--	--	40	25
Spain	--	--	29	37
Thailand [1]	--	--	31	30
Uganda	--	--	22	55
Zaire	--	--	35	33

[1] Excludes tin slag.
[2] Material reported from Brazil or Canada as columbite represents primarily pyrochlore.

FOREIGN TRADE

Most of the columbium and tantalum exported from the United States was received by West Germany, Japan, and the United Kingdom. Tantalum and tantalum alloy powder, the largest export item by quantity and value, was shipped to Japan (29%), West Germany (24%), the United Kingdom (19%), France (11%), Italy (6%), Austria (4%), and the Netherlands (3%). The remainder of the tantalum and tantalum alloy powder (4% of the total) was destined for Canada, Switzerland, Australia, India, Sweden, New Zealand, and Belgium-Luxembourg. Unwrought tantalum alloys in crude form and scrap, the second largest export item by volume, was destined for West Germany (55%), Japan (16%), the United Kingdom (11%), Italy (5%), Belgium-Luxembourg (4%), and Austria (4%). The remainder of this material (5% of the total) was exported to France, Canada, Mexico, Brazil, Norway, and the Netherlands. Wrought tantalum and tantalum alloys, the second largest export item by value, was shipped to the United Kingdom (23%), Japan (19%), France (17%), West Germany (16%), Switzerland (7%), Canada (5%), and Italy (4%). The remainder of the tantalum material (9% of the total) was exported to Austria, the Netherlands, Mexico, Belgium-Luxembourg, India, Argentina, Australia, Brazil, Sweden, Ireland, Israel, Gibraltar, and the Republic of South Africa. Tantalum ore and concentrate, believed not to be of domestic origin, was shipped to Japan (62%), the United Kingdom (29%), and West Germany (9%). Wrought columbium and columbium alloys were mostly exported to West Germany (55%), Japan (17%), the United Kingdom (9%), the Republic of South Africa (7%), Canada (6%), and France (5%). The rest of this columbium material (1% of the total) was exported to Belgium-Luxembourg, Italy, and Czechoslovakia. Unwrought columbium alloys in crude form and scrap were shipped mostly to West Germany (68%), Japan (16%), and Canada (11%); the remainder (5% of the total) went to Saudi Arabia and Switzerland.

Imports for consumption of unwrought columbium metal, waste, and scrap, all from West Germany, decreased from 450 pounds valued at $7,227 in 1971 to 400 pounds valued at $3,714 in 1972. In 1972 imports for consumption of wrought columbium metal increased to 265 pounds valued at $14,876 from 76 pounds valued at $16,526 in 1971. This import item came from Belgium-Luxembourg (84%), Canada (10%), the Netherlands (5%), and the United Kingdom (1%). Unwrought columbium alloys were not imported in 1972.

Imports for consumption of unwrought tantalum metal, including waste and scrap, increased approximately 80% in 1972 to 72,246 pounds valued at $543,109. Imports of wrought tantalum, from Australia (51%) and Canada (49%), decreased from 111 pounds valued at $5,214 in 1971 to 90 pounds valued at $3,664 in 1972. Imports of unwrought tantalum alloys, all from West Germany, totaled 2,000 pounds valued at $13,183 and represented a sharp increase over the 7 pounds valued at $279 that were imported in 1971.

Table 8.—U.S. exports of columbium and tantalum, by class

(Thousand pounds, gross weight, and thousand dollars)

Class	1971		1972	
	Quantity	Value	Quantity	Value
Columbium and columbium alloys, unwrought and waste and scrap	3	63	2	40
Columbium and columbium alloys, wrought	18	525	27	413
Tantalum ores and concentrate	48	146	19	29
Tantalum and tantalum alloys, wrought	26	1,175	24	1,265
Tantalum metals and alloys, in crude form and scrap	168	1,290	122	1,014
Tantalum and tantalum alloy powder	85	2,519	171	3,572

Table 9.—Receipts of tin slags reported by consumers

(Thousand pounds)

Year	Gross weight	Cb_2O_5 content	Ta_2O_5 content
1969	8,327	649	453
1970	10,275	713	573
1971	9,064	753	596
1972	9,782	783	762

Table 10.—U.S. imports for consumption of columbium-mineral concentrates, by country

(Thousand pounds and thousand dollars)

Country	1970		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value
Angola	19	47	22	52	--	--
Argentina	8	14	--	--	--	--
Belgium-Luxembourg [1]	37	68	32	60	5	9
Brazil	3,312	2,430	1,927	1,222	2,347	1,363
Burundi-Rwanda	21	38	[2] 18	[2] 24	--	--
Canada	1,271	669	341	267	65	52
Congo (Brazzaville)	--	--	11	23	--	--
Germany, West	7	23	11	3	2	2
Malaysia	104	103	60	44	75	44
Mozambique	10	19	12	18	--	--
Nigeria	682	478	483	307	648	362
Portugal	32	75	14	26	14	24
Singapore	19	21	31	31	--	--
Spain	--	--	11	21	6	9
Uganda	4	3	--	--	15	11
United Kingdom	50	75	--	--	50	51
Zaire	143	282	81	124	--	--
Total	5,719	4,345	3,054	2,222	3,227	1,927

[1] Presumably country of transshipment rather than original source.

[2] Rwanda separately classified Jan. 1, 1971.

Table 11.—U.S. imports for consumption of tantalum-mineral concentrates, by country

(Thousand pounds and thousand dollars)

Country	1970		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value
Argentina	2	10	2	8	--	--
Australia	13	31	62	174	404	852
Belgium-Luxembourg [1]	17	42	14	35	16	27
Brazil	178	624	159	549	362	787
Burundi-Rwanda	31	58	[2] 31	[2] 55	[2] 66	[2] 81
Cameroon	4	12	--	--	--	--
Canada	477	1,724	522	1,818	119	416
Congo (Brazzaville)	--	--	--	--	33	78
French Guiana	2	6	2	8	--	--
Germany, West	--	--	31	62	48	109
Japan	5	8	--	--	--	--
Malaysia	--	--	16	10	--	--
Mozambique	--	--	47	108	30	65
Nigeria	4	10	50	33	3	2
Portugal	10	22	7	11	--	--
South Africa, Republic of	--	--	20	29	--	--
Spain	52	105	35	69	5	9
Thailand	--	--	26	52	26	33
Uganda	--	--	4	4	2	1
United Kingdom	22	45	--	--	27	37
Western Africa, n.e.c	7	13	--	--	--	--
Zaire	222	521	152	307	88	166
Total	1,046	3,231	1,180	3,332	1,229	2,663

[1] Presumably country of transshipment rather than original source.
[2] Rwanda separately classified Jan. 1, 1971.

Table 12.—U.S. import duties

Tariff classification number	Article	Rate of duty per pound [1] (effective Jan. 1, 1972–73)
601.21	Columbium concentrate	Free
601.42	Tantalum concentrate	Do.
607.80	Ferrocolumbium and ferrotantalum-columbium	5% ad valorem.
	Columbium:	
628.15	Unwrought, waste and scrap	Do.
628.20	Wrought	9% ad valorem.
628.17	Unwrought Cb alloys	7.5% ad valorem.
	Tantalum:	
629.05	Unwrought, waste and scrap	5% ad valorem.
629.10	Wrought	9% ad valorem.
629.07	Unwrought Ta alloys	7.5% ad valorem.
423.00	Columbium and tantalum chemicals	5% ad valorem.

[1] Not applicable to Communist countries.

WORLD REVIEW

Australia.—Vultan Minerals Ltd. initiated steps to mine a new area for tin and tantalite near its Queenbushes plant in West Australia. Preliminary tests have indicated the presence of sufficient ore to justify the erection of a simple treatment plant, the output from which is to be transported to the main plant for upgrading.[7]

Brazil.—During 1972 Brazil maintained its standing as the major producer of columbium minerals. Companhia Brasileira de Metalúrgia e Mineração (CBMM), the country's leading producer, continued to recover columbium from rich pyrochlore ores at the Araxá mine and to produce ferrocolumbium (FeCb) at its pyrometallurgical plant. Production of columbium oxide in 1972 was 58% above the 8,038,000 pounds produced during 1971. This increase was attributed largely to the increased consumption of columbium in pipeline and other high-strength, low-alloy steels. In 1971, approximately 3.2 million pounds of FeCb were produced from 5.3 million pounds of pyrochlore concentrate. With the exception of approximately 0.3 million pounds sold domestically and ap-

[7] Metal Bulletin (London). Vultan Extends Operations. No. 5684, Mar. 17, 1972, p. 15.

proximately 0.6 million pounds that apparently went into stocks, all of the FeCb was exported to the United States (1.2 million pounds), continental Europe (0.6 million pounds), Japan (0.3 million pounds), Canada (0.1 million pounds), and the United Kingdom (0.1 million pounds).

In 1972, an arrangement was consummated between CBMM and the state-owned Companhia Agricola de Minas Gerais (CAMIG) for the joint mining of pyrochlore from their respective mining concessions near Araxá, Minas Gerais, thus ending a lengthy dispute over mining on CAMIG ground by CBMM on a royalty payment basis. Under the new arrangement, which is to become effective on January 1, 1973, a new firm, Companhia Mineradora do Pirocloro de Araxá (COMPIRA), was formed. The new firm was to lease the mining concessions from CAMIG and CBMM, and was to sell pyrochlore ore on a cost plus 10% basis to CBMM exclusively for beneficiation to concentrate (± 60% Cb_2O_5) or the manufacture of ferrocolumbium. CBMM was to be the marketing agent for these products, and CAMIG was to participate in the net profits from the sale of columbium products. This new arrangement between CAMIG and CBMM was to continue for 30 years, with an automatic extension for another 30 years unless either party wishes to withdraw. Fifty-one percent of COMPIRA is to be owned by CAMIG and 49% by CBMM.

Columbium and tantalum in columbite-tantalite and microlite continued to be produced in limited quantity from relatively small pegmatite operations located principally in Minas Gerais. All output was exported. In 1970 these exports amounted to 90,389 pounds of columbite and 458,557 pounds of tantalite, the United States being the principal destination. In 1971 comparable exports were 138,890 pounds and 639,334 pounds, respectively, and the United States again was the principal destination.

Canada.—St. Lawrence Columbium and Metals Corp. produced concentrates from its underground mining operations and mill facilities near Oka, Quebec, and continued to be Canada's sole columbium producer. The operations in fiscal 1972 (ended Sept. 30, 1972) milled 589,147 tons of ore, an increase of 44% over the 408,500 tons produced in fiscal 1971.

About 70,000 feet of diamond drilling and metallurgical tests have established that the St. Honore carbonatite deposit, near Chicoutimi, Quebec, was one of the largest columbium deposits in the world.[8] It consists of two mineralized zones totaling 60 million tons of ore of about 0.66 percent Cb_2O_5. It was stated in the agreement between the two companies, Copperfields Mining Corp. Ltd. and the Quebec Government exploration company Quebec Mining Exploration Co. (SOQUEM), that, following various financing operations for each stage of development, each party would hold a working interest of 50%. It was expected that underground operations would start in 1973.

The geology of a major pyrochlore deposit located in the lowlands of Northern Ontario and known as the James Bay deposit was described in a recent article.[9]

Tantalum Mining Corporation of Canada, Ltd. (TANCC), a wholly owned subsidiary of Chemalloy Minerals Ltd., has found what appears to be a new tantalum ore body at its Bernic Lake, Manitoba, property. The new zone was located in a granite pegmatite sill which underlies and parallels the ore zone presently being mined. The first and second drill holes cut ore reading 0.19% and 0.24% Ta_2O_5, respectively.

Japan.—The Japanese company, Showa Denko, was waiting for approval from the Ministry of International Trade and Industry (MITI) on a proposal for a financial and technical link with Kawecki Berylco Industries, Inc., of the United States for the setting up of a tantalum-producing company that would allow full integration (refining to fabricating) of tantalum products. The proposal also involved transferring production of tantalum powder from the Showa Denko plant at Higashi Nagahara to the new company. This plant's current output of tantalum powder was reported to be 30 tons annually.[10]

MITI was considering a program for Japan Rare Metals Co. to set up stockpiles in Japan of minor metals and ores, such as tantalum, beryllium, columbium, zirconium, and rare earths, as a means of con-

[8] Mining Journal. Soquem's Progress Reviewed. V. 278, No. 7129, Apr. 7, 1972, p. 277.
[9] Stockford, H. R. The James Bay Pyrochlore Deposit. Canadian Min. and Met. Bull., v. 65, No. 722, June 1972, pp. 61–69.
[10] World Minerals and Metals. Tantalum Project Proposed. No. 6, March/April 1972, p. 26.

trolling demand and supply and thus of stabilizing prices.[11]

The Japanese tantalum industry received many inquiries from Peking for tantalum powder and products and was anticipating a trade boom with the People's Republic of China.[12]

Nigeria.—The Quebec and Titanium Corp., a Canadian subsidiary of Kennecott Copper Corp., plans to sell its holdings in the Tin and Associated Mining, Ltd. (TAM) columbite mine. The completion of the sale was contingent upon the necessary investment guarantee by the Japanese Government to Mitsubishi Corp. and Sumitomo Metal Mining Co., Ltd., as well as on agreement from the Nigerian Government to the ownership transfer.

The Kennecott Copper Corp. considers TAM too small an operation to warrant the funds and effort required to establish the mine on an economically viable basis. Difficulty in recruiting satisfactory expatriate personnel to manage and operate the mine in its isolated location coupled with the general decrease of columbite prices has decreased Kennecott's interest in the mine.

Thailand.—Tantalum-bearing slags produced by Thailand Smelting and Refining Company, Ltd. (THAISARCO), a 50–50 venture between Union Carbide Corp. and Royal Dutch Shell, are to be sold by Billiton Trading Co., a subsidiary of Billiton Handelsgesellschaft.[13] Union Carbide, which has been responsible for the management and tantalum sales, was to retain its ownership in THAISARCO, but the Billiton Trading Co. was to assume the responsibility for worldwide marketing of the Thai slags containing 12% Ta_2O_5 and 7% Cb_2O_5. THAISARCO produces an estimated 600,000 pounds of Ta_2O_5 annually.

Zaire.—The greatest economic wealth of Zaire was reported to be in its minerals, which provide 80%, by value of the nation's exports and supply 45% of Government revenues. The high costs of in-country transportation have cut into the profit margins that were enjoyed by mining companies in the late 1960's. The squeeze has been felt more in Kivu Province where cassiterite, gold, wolframite, and columbium-tantalum ore are the basic products of the mines and where transportation is a bigger problem. Société Minière Union Carbide-Somikubi (SOMUCAR), a mining company in Kivu Province in which Union Carbide held a 50% interest, closed down after studies showed that the planned pyrochlore production would be uneconomic.

Zaire-Etain, a Zairian company owned 50% by the Government and 50% by the Compagnie Géologique et Minière des Ingénieurs et Industriels Belges (GÉOMINES), produced 143,299 pounds of columbium-tantalum as a byproduct of tin mining in 1971, which was approximately 35,000 pounds less than that produced in 1970. The company employs 49 Europeans and 114 Zairian management personnel and 2,700 workers.

Philips Brothers Sobaki (PHIBRAKI), owned 50% by Philips/Englehard (South African) and 50% by SOBAKI of the Empain group (Belgian), produced mixed cassiterite and columbium-tantalum ore from deposits at Kabili. Production in 1971 was 205,910 pounds, 24% above the 165,632 pounds produced in 1970. Cobelmin-Zaire, a Zairian subsidiary of Compagnie Belge d'Entreprises Minières (MGL), operates the concessions owned by MGL. Production of columbium-tantalum concentrates in 1971 was 108,828 pounds.

TECHNOLOGY

A report issued by the Bureau of Mines showed that columbium, tantalum, zirconium, and titanium can be separated from waste residues generated by the chlorination of rutile used for production of titanium tetrachloride ($TiCl_4$).[14]

Engineers at Argonne National Laboratory and the Institute for Experimental Particle Physics, Karlsruhe, West Germany, developed a technique for building particle accelerator components of superconducting

[11] Metal Bulletin (London). Stockpile for Minors. No. 5710, June 23, 1973, p. 16.
[12] Metal Bulletin (London). Cheer for Japanese Tantalum. No. 5688, Mar. 24, 1972, p. 17.
[13] Metals Week. Billiton To Handle Thaisarco Tantalum. V. 43, No. 44, Oct. 30, 1972, p. 6.
[14] Merrill, C. C., and D. E. Couch. Separation of Columbium, Tantalum, Titanium, and Zirconium From Titanium Chlorination Residues. BuMines Rept. of Inv. 7671, 1972, 8 pp.

columbium.[15] The Argonne National Laboratory reports that instability problems with columbium have been solved. Components of superconducting columbium when cooled to liquid helium temperatures can generate electric fields as high as 800,000 volts per foot, and require only 1/50,000 the power needed by similar devices of conventional copper construction.

Scientists at RCA Laboratories in Princeton used columbium-gallium to achieve superconductivity at a temperature above 20° K.[16]

Westinghouse Electric Corp. displayed a prototype electric generator with a magnet core refrigerated to minus 452.2° F.[17] The superconducting magnet, made by the winding of 2 miles of columbium-titanium alloy wire 1/1000 inch in diameter and cooled with helium, carries 50 times more electricity than conventional generator windings of that size, and produces a magnetic field three or four times greater.

The continuing interest in methods of upgrading and extracting tantalum and columbium values from tin slags was reflected by a patent issued during the year.[18]

[15] Chemical and Engineering News. Niobium Accelerator Components. V. 50, No. 16, Apr. 17, 1972, p. 20.
[16] Popular Science. More Cool Air for Energy Crisis. November 1972, p. 69.
[17] American Metal Market. Westinghouse Hot on Future of Cold Temperature Generator. V. 79, No. 196, Oct. 26, 1972, pp. 2, 4.
[18] Gustison, R. A. (assigned to Kawecki Berylco Industries, Inc.). Upgrading the Tantalum and Columbium Contents of Oxidic Metallurgical Products. U.S. Pat. 3,658,511, Apr. 25, 1972.

Table 13.—Columbium and tantalum: World production of mineral concentrates by country [1]

(Thousand pounds, gross weight)

Country [2]	1970	1971	1972 p
Argentina: Columbite-tantalite	10	e 10	e 10
Australia: Columbite-tantalite	r 222	165	e 420
Brazil:			
Columbite-tantalite:			
Columbium concentrate [3]	90	139	e 140
Tantalum concentrate [3]	461	639	e 640
Pyrochlore	29,288	13,435	21,242
Canada:			
Pyrochlore e	9,838	4,889	8,173
Tantalite e	594	843	609
Malaysia: Columbite-tantalite	134	54	e 60
Mozambique:			
Columbite-tantalite	r 163 (combined with Tantalite)	11	--
Tantalite		123	93
Microlite (tantalum concentrate)	140	117	134
Nigeria: Columbite-tantalite:			
Columbite concentrate	3,563	3,040	2,961
Tantalite concentrate	10	9	2
Portugal: Tantalite	9	24	(4)
Rhodesia, Southern e	100	90	90
Rwanda: Columbite-tantalite e	66	80	80
South Africa, Republic of: Tantalite	7	2	1
Thailand: Columbite-tantalite	126	93	29
Uganda: Columbite-tantalite	6	17	4
Zaire: Columbite-tantalite	322	234	e 265
Total	r 45,149	24,014	34,953

e Estimate. p Preliminary. r Revised.
[1] Data generally has been presented as reported in sources, divided into columbite concentrate and tantalite concentrate where information is available to do so, reported as columbite-tantalite where it is not. Data in table excludes columbium and tantalum bearing tin concentrates and slags.
[2] In addition to the countries listed, Spain, South-West Africa and the U.S.S.R. also produce columbium and tantalum mineral concentrates, but information is inadequate to make reliable estimates of output levels.
[3] Exports.
[4] Less than ½ unit.

Copper

By Harold J. Schroeder [1]

World mine production of copper increased 10% to 7.31 million tons, a record high for the fifth consecutive year. The increase was broadly shared by almost all major producing countries. A number of new mine projects, notably in Papua New Guinea, Western Canada, Indonesia, the Republic of South Africa, and Zaire came onstream during the year.

In the United States, mine, smelter, and refinery outputs increased substantially from the strike-curtailed level of 1971 with smelter and refinery outputs from primary materials at record high quantities. Consumption of refined copper also increased significantly to the largest quantity since the record high of 1966. Foreign trade in unmanufactured copper was characterized by an increase in imports and a decline in exports. Changing market conditions were reflected in a price increase of 2¼ cents in February and a decrease of 2 cents in July for a yearend quotation of 50½ to 50¾ cents per pound for electrolytic wirebar copper.

[1] Physical scientist, Division of Nonferrous Metals—Mineral Supply.

Table 1.—Salient copper statistics

	1968	1969	1970	1971	1972
United States:					
Ore produced .... thousand short tons..	170,054	223,752	257,729	242,656	266,831
Average yield of copper ... percent....	0.60	0.60	0.59	0.55	0.55
Primary (new) copper produced—					
From domestic ores, as reported by—					
Mines .... short tons..	1,204,621	1,544,579	1,719,657	1,522,183	1,664,840
Value .... thousands..	$1,008,195	$1,468,400	$1,984,484	$1,583,071	$1,704,796
Smelters .... short tons..	1,234,724	1,547,496	1,605,265	1,470,815	1,649,130
% of world total	20	24	24	22	23
Refineries .... short tons..	1,160,925	1,468,889	1,521,183	1,410,523	1,680,412
From foreign ores, matte, etc., as reported by refineries .... do....	276,461	273,926	243,911	181,259	192,821
Total new refined, domestic and foreign .... do....	1,437,386	1,742,815	1,765,094	1,591,782	1,873,233
Secondary copper recovered from old scrap only .... do....	520,772	574,890	504,071	445,157	458,194
Exports:					
Metallic copper .... do....	313,741	241,254	273,577	262,838	241,600
Refined .... do....	240,745	200,269	221,211	187,654	182,743
Imports, general:					
Unmanufactured .... do....	709,975	413,860	392,480	359,479	415,611
Refined .... do....	400,278	131,171	132,143	163,988	192,379
Stocks Dec. 31: Producers:					
Refined .... do....	48,000	39,000	130,000	75,000	57,000
Blister and materials in solution do....	272,000	291,000	340,000	303,000	281,000
Total .... do....	320,000	330,000	470,000	378,000	338,000
Withdrawals (apparent) from total supply on domestic account:					
Primary copper .... do....	1,576,000	1,683,000	1,585,000	1,623,000	1,901,000
Primary and old copper (old scrap only) .... do....	2,097,000	2,258,000	2,089,000	2,068,000	2,359,000
Price: Weighted average, cents per pound..	42.2	47.9	58.2	52.0	51.2
World:					
Production:					
Mine .... short tons..	5,640,921	6,223,820	6,638,042	6,653,048	7,313,536
Smelter .... do....	6,050,822	6,413,940	6,751,531	6,739,404	7,300,429
Price: London, average cents per pound....	56.13	66.24	62.96	48.49	48.53

Table 2.—Copper statistics

(Short tons)

Year	United States: Mine production	Average yield of copper ore (percent)	Refined production from— Domestic ores	Foreign ores	Scrap	Total	Production from scrap, total	Imports (refined)	Exports (refined)	Consumption[1] (refined)	Price,[2] (cents per pound)	World (mine) production (thousand tons)
1931	528,875	1.50	537,303	213,418	188,300	939,021	347,000	87,225	202,698	639,300	8.24	1,546
1932	238,111	1.83	222,539	117,895	140,500	480,934	248,180	83,897	110,977	400,100	5.67	1,002
1933	190,643	2.11	240,669	130,120	193,100	563,889	338,100	5,432	124,582	532,500	7.15	1,155
1934	237,401	1.92	233,029	212,331	220,400	665,760	377,400	27,417	262,366	543,000	8.53	1,416
1935	380,491	1.89	338,321	250,484	270,000	858,805	448,900	18,071	260,735	711,400	8.76	1,649
1936	614,516	1.54	645,462	177,027	260,000	1,082,489	484,600	4,782	220,390	916,200	9.58	1,902
1937	841,998	1.29	822,253	244,561	285,600	1,352,414	532,100	7,487	295,064	980,500	13.27	2,575
1938	557,763	1.34	552,574	239,842	192,400	984,816	359,800	1,802	370,545	599,400	10.10	2,274
1939	728,320	1.25	704,873	304,642	151,370	1,160,885	499,700	16,264	372,777	866,200	11.07	2,405
1940	878,086	1.20	927,239	386,317	170,839	1,484,395	532,046	68,337	356,431	1,179,600	11.40	2,664
1941	958,149	1.15	975,408	419,901	128,068	1,523,377	726,396	346,994	103,602	1,769,600	11.87	2,820
1942	1,080,061	1.09	1,064,792	349,769	110,913	1,525,474	927,755	401,436	131,406	1,718,900	11.87	2,980
1943	1,090,818	1.04	1,082,079	297,184	131,774	1,511,037	1,086,047	402,762	175,859	1,633,800	11.87	2,968
1944	972,549	.99	973,852	247,335	95,979	1,317,166	950,942	492,395	68,373	1,600,000	11.87	2,781
1945	772,894	.93	775,738	332,861	101,677	1,210,276	1,006,516	531,367	48,563	1,379,272	11.87	2,384
1946	608,737	.91	578,429	300,233	116,452	995,114	803,546	154,371	52,629	1,135,198	13.92	2,046
1947	847,563	.90	909,213	250,757	279,334	1,439,304	961,741	149,478	147,642	1,463,294	21.15	2,455
1948	834,813	.92	860,022	247,424	257,248	1,364,694	972,788	249,124	142,598	1,420,584	22.20	2,531
1949	752,750	.91	695,015	232,912	228,414	1,156,341	713,143	275,811	137,827	1,129,686	19.36	2,488
1950	909,343	.89	920,748	319,086	206,561	1,446,395	977,239	317,363	144,561	1,424,434	21.46	2,758
1951	928,330	.90	951,559	255,429	155,532	1,362,520	932,282	238,972	133,305	1,416,865	24.37	2,900
1952	925,359	.85	923,192	254,504	142,763	1,320,459	903,197	346,960	174,135	1,479,732	24.37	3,017
1953	926,448	.85	932,232	360,885	210,355	1,503,472	958,464	274,111	109,580	1,494,215	28.92	3,055
1954	835,472	.83	841,717	370,202	206,425	1,418,344	839,907	215,086	215,951	1,254,729	29.82	3,111
1955	998,570	.83	997,499	344,960	236,317	1,578,776	989,004	202,312	199,819	1,502,004	37.51	3,416
1956	1,104,156	.78	1,080,207	362,426	261,199	1,703,832	930,664	191,745	223,103	1,521,389	42.00	3,786
1957	1,086,859	.77	1,050,496	403,680	236,906	1,691,082	841,887	162,309	346,025	1,352,124	30.17	3,892
1958	979,329	.79	1,001,645	350,875	246,008	1,598,528	797,388	128,464	384,868	1,250,677	26.31	3,780
1959	824,846	.74	796,452	301,795	250,233	1,348,480	930,570	214,058	158,938	1,463,031	30.99	4,024
1960	1,080,169	.73	1,121,286	397,641	291,714	1,810,641	871,388	142,709	433,762	1,349,896	32.34	4,652
1961	1,165,155	.75	1,181,015	369,124	270,418	1,820,557	848,939	66,855	428,718	1,462,830	30.32	4,848
1962	1,228,421	.75	1,214,146	397,584	289,748	1,901,478	921,828	98,820	336,525	1,599,676	31.00	5,084
1963	1,213,166	.74	1,219,342	377,009	302,079	1,898,430	974,426	119,219	311,479	1,744,273	31.00	5,088
1964	1,246,780	.73	1,259,852	396,543	351,050	2,007,445	1,093,021	139,974	316,230	1,825,281	32.35	5,297
1965	1,351,734	.70	1,335,660	376,133	445,052	2,156,845	1,253,250	137,443	324,965	2,004,623	35.36	5,549
1966	1,429,152	.67	1,353,087	357,897	491,324	2,202,308	1,334,249	162,602	273,071	2,359,954	36.00	5,485
1967	954,064	.63	846,551	286,431	406,614	1,539,596	1,159,907	330,571	159,353	1,935,592	38.10	5,224
1968	1,204,621	.60	1,160,925	276,461	416,579	1,853,965	1,218,340	400,278	240,745	1,880,300	41.17	5,641
1969	1,544,579	.60	1,468,889	273,926	499,122	2,241,937	1,375,493	131,171	200,269	2,142,218	47.43	6,224
1970	1,719,657	.59	1,521,183	243,911	511,609	2,276,703	1,247,602	132,143	221,211	2,043,303	58.07	6,638
1971	1,522,183	.55	1,410,523	181,259	400,662	1,992,444	1,200,120	163,988	187,654	2,019,507	52.09	6,653
1972	1,664,840	.55	1,680,412	192,821	423,243	2,296,476	1,300,973	192,379	182,743	2,238,867	51.44	7,314

[1] Reported actual consumption beginning with 1945. Prior to 1945 data are apparent consumption of refined copper.
[2] American Metal Market price for electrolytic copper in New York until April 1955; thereafter, delivered U.S. destinations basis; and exclusive of bonus payments of the Office of Metals Reserve under the Premium Price Plan during the period Feb. 1, 1942, to June 30, 1947.

Legislation and Government Programs.—The total copper in the national stockpile on December 31, 1972, was 60,112 tons of oxygen-free, high-conductivity (OFHC) copper, 7,067 tons of copper in beryllium-copper master alloys, and 191,480 tons of copper in "other" classifications, for a total of 258,659 tons, 33% of the objective of 775,000 tons.

The Office of Minerals Exploration (OME) continued to offer up to 50% government participation in the authorized cost of exploration for copper deposits. There were no contracts executed in 1972 that involved copper.

Regulations were amended to change the base period from calendar year 1969 to calendar year 1971 for calculating set-asides for certain brass mill, wire mill, and foundry products retained under the program of copper controlled materials for defense purposes.

The duty on imported unmanufactured copper was reduced to 0.8 cent per pound, effective January 1, 1972, as the last step in the progressive reduction of the rate of duty in accord with the Kennedy Round Trade Expansion Act of 1962. Duties suspended by public laws since 1966 were reimposed when the latest extension to Public Law 91–298 expired June 30, 1972.

DOMESTIC PRODUCTION

PRIMARY COPPER

Mine Production.—Domestic mine production was 1.66 million tons, an increase of 9% from the strike-curtailed output of 1971, but 3% below the record high of 1970. Principal copper-producing States were Arizona, with 55% of the total, Utah (16%), New Mexico (10%), Montana (7%), Nevada (6%), and Michigan (4%). These six States accounted for 98% of the total domestic production.

Open pit mines accounted for 80% of mine output and underground mines for 20%. The production of copper from dump and in-place leaching, largely recovered by precipitation with iron, was 171,000 tons or 10% of mine output. Total copper recovered by leaching methods was 253,500 tons, of which 221,900 tons was precipitated with iron and 31,600 tons was electrowon.

Duval Corp., a subsidiary of Penzoil Co., operated the Duval Sierrita mine near Tucson, Ariz., for the second full year and in November and December achieved an average daily operating rate of 84,600 tons of ore. Duval's Esperanza property adjacent to Sierrita remained closed during the year owing to a shortage of smelting capacity to treat the stockpiled concentrates, but is expected to resume production in 1973.

The Anaconda Company operated mines in Arizona, Montana, and Nevada with production of 233,471 tons of copper, a recovery from the strike-curtailed output of 182,014 tons in 1971. The Twin Buttes, Ariz., open pit mine produced 66,486 tons of copper from sulfide ore. Approximately 20 million tons of stockpiled oxide-type ore will be processed in a 10,000-ton-per-day leach-electrowinning plant scheduled for completion in 1975. Output capacity of the plant will be 30,000 tons of electrolytic copper a year. In Montana, the underground mines contributed 20,833 tons and the Berkeley pit 104,934 tons of copper. As part of an expansion program the concentrator capacity is being increased from 40,000 to 50,000 tons per day and plans are underway to develop open pit operations in an area east of the Berkeley pit. Production at the Yerington, Nev., property was 41,218 tons compared with 42,541 tons the preceding year. Exploration and feasibility planning continued toward development of a large underground mine at Carr Fork in the Bingham District of Utah with anticipated production by 1977.

Kennecott Copper Corp. operated mines in Arizona, Nevada, New Mexico, and Utah; these mines produced a combined total of 460,600 tons of copper, compared with 456,100 tons in strike-affected 1971. The Utah Copper Div. accounted for 258,000 tons of the total followed by the Ray Mines Div. (Arizona) with 90,200 tons, the Chino Mines Div. (New Mexico) with 73,400 tons, and the Nevada Mines Div. with 39,000 tons. A limiting factor on mine copper production was smelter throughput, which was adversely affected by operating problems and construction of plant modifications to meet anticipated air pollution control regulations.

The American Smelting and Refining

Company (Asarco) operated three copper mines in the vicinity of Tucson, Ariz. The Mission unit produced 45,400 tons of copper in concentrate compared with the 1971 strike-curtailed output of 40,600 tons. The Silver Bell unit was unaffected by the 1971 strike and output increased slightly to 23,600 tons of copper in concentrate and precipitates. Production at the San Xavier mine was limited to copper-bearing flux ore for use at Asarco's Hayden smelter. Two new Arizona copper mining projects were initiated by Asarco in 1972. One project was construction of a leach plant to treat 4,000 tons per day of copper oxide ore from the north mine at San Xavier. Startup is scheduled during the first quarter of 1973. The second project is the Sacaton mine at Casa Grande, with an open pit mine and mill expected to be in operation early in 1974 and underground mining of deeper ore anticipated in 1979. The combined annual capacity of both projects will be 33,000 tons of copper contained in concentrate and precipitates.

Mines of the Phelps Dodge Corp. produced 305,400 tons of copper compared with a record high 313,500 tons in 1970 and the strike-affected output of 281,200 tons in 1971. Of the output 119,800 tons was derived from Morenci, Ariz., 57,900 tons from Ajo, Ariz., 48,500 tons from Bisbee, Ariz., 78,800 tons from Tyrone, N. Mex., and 400 tons from other sources. Expansion of the Tyrone mine from a capacity of 60,000 to 100,000 tons per year was substantially completed by August. The Tyrone expansion will be offset by probable closure of the Bisbee open pit operations in late 1973 and of the Bisbee underground operations shortly thereafter. Stripping continued at the Metcalf property near Morenci and construction of the concentrator is underway with initial output planned for early 1975. Rated capacity of the Metcalf project is 50,000 tons of copper per year. A preliminary development program at Safford, Ariz., was in progress to determine the feasibility of mining a deep ore body containing an estimated 250 million tons of ore with an average grade of 0.92% copper. Work included a haulage drift into the ore at a depth of 1,800 feet and mining a test block to determine the caving characteristics of the ore.

Cities Service Co., through its North American Chemicals and Metals Group, operated copper mines in Arizona and Tennessee that produced 44,900 tons of copper, compared with 44,000 tons in 1971. Preproduction stripping and mill construction were begun for development of the large, low-grade Pinto Valley copper deposit in the Miami, Ariz., area, with initial output scheduled for mid-1974. A production rate of 40,000 tons of mill feed per day is expected by early 1975. Plans were underway for underground mining of the high-grade Miami East ore body at a depth of 2,500 to 3,700 feet; production is scheduled to start in 1974 and to reach a level of 2,000 tons per day by 1978.

The White Pine Michigan operations of White Pine Copper Co. milled a record high 8,250,000 tons of copper ore averaging 1.0% copper with an 85.77% copper recovery in concentrate. The mine continued to experience adverse ground conditions, particularly in the vicinity of a major fault, which resulted in monthly variations of ore mined per day from approximately 20,000 to 25,000 tons. Research on mining methods and practices to overcome the roof control problem included tests of longwall mining and use of resin-anchored rock bolts.

Magma Copper Co. operated the San Manuel and Superior mines in Arizona throughout the year. The San Manuel underground mine demonstrated its ability to produce up to 65,000 tons of ore per day. At Superior, the program of doubling mine and mill capacity to 3,300 tons of ore per day is ahead of the original schedule and anticipated to be in operation during the last quarter of 1973. Output of copper in concentrate will be increased from a rate of 20,000 to 40,000 tons per year.

The Inspiration Consolidated Copper Co. operated the Thornton, Live Oak, Red Hill, and Black Copper mines in the vicinity of Inspiration, Ariz.; 14.3 million tons of waste and 7.8 million tons of ore were mined. The ore processed in the plant yielded 41,158 tons of copper. An additional 9,588 tons was recovered from leaching dumps and mined-out areas and by heap leaching. At the Ox Hide mine 2.4 million tons of oxide ore was mined and 4,475 tons of copper was recovered by leaching. At the Christmas open pit mine, southeast of Miami, Ariz., 9.1 million tons of waste and 1.9 million tons of ore was mined; 10,611 tons of copper was recovered. Total production of copper by the company was 65,832 tons, 17% above the strike-curtailed output of 1971.

Pima Mining Co. produced 79,500 tons of copper in concentrate from milling 18.7 million tons of copper-molybdenum ore from its mine south of Tucson, Ariz. A 35% expansion in milling capacity was completed early in the year and by yearend exceeded rated capacity. At the end of 1972 ore reserves totaled 240 million tons averaging 0.5% copper.

Bagdad Copper Corp. at its Arizona mine, produced 12,230 tons of copper in concentrate and 6,700 tons as cathode copper, the latter obtained from oxide ore by a leach-electrowinning process. Grade of sulfide ore mined in 1972 averaged 0.70% copper. Reserves for the present operation consist of 38 million tons of sulfide ore with a copper content of 0.66%, overlain by approximately 12.5 million tons of copper oxide material and overburden. The company has under consideration a planned expansion program to increase the mining rate fivefold to 30,000 tons of sulfide ore per day. Sulfide reserves for the expanded operation which include the reserves for the present operation are estimated to be 303 million tons averaging 0.47% copper. Total oxidized copper material are 40 million tons of approximately 0.36% copper overlying the sulfide ore plus 77 million tons of 0.21% acid soluble copper now stockpiled in waste dumps.

The Bruce Mine Div. of Cyprus Mines Corp. operated its underground copper-zinc mine near Bagdad, Ariz., at near capacity during 1972. New milling equipment and higher ore grade increased output 36% to 3,400 tons of copper in concentrate produced from processing 96,200 tons of ore averaging 3.92% copper and 13.7% zinc. Known ore reserves are sufficient for at least 5 years at the present operating rate.

Ranchers Exploration and Development Co. moved about 3.9 million tons of overburden and 4.5 million tons of ore at their Arizona Bluebird property. The ore, with an average grade of 0.44% copper, was placed on dumps for processing by a leaching-solvent extraction-electrowinning method of recovery. Production of refined copper cathodes by this method increased 18% to a record high 7,000 tons. A leach-precipitation plant to produce cement copper from about 300,000 tons of stockpiled mixed oxide-sulfide ore containing about 2% copper at the Big Mike copper property near Winnemucca, Nev., was placed in operation. Additional ore in place is available for treatment at the plant. In March, Rancher's initiated an in situ leaching operation at the Old Reliable deposit near San Manuel, Ariz., with a blast using 4 million pounds of explosives to fracture an ore deposit with reserves estimated at 4 million tons of 0.74% copper. Leach solution was introduced at the surface in August and precipitation of the copper from the pregnant liquor was begun by yearend. It is estimated that about 15,000 tons of copper will be recovered by this method over a 5-year period.

Hecla Mining Co. reached the 6,600-foot point of a planned 15-degree decline of 7,500 feet to develop their Arizona Lakeshore copper mine. Crosscuts and development headings were being driven into both the sulfide and oxide ore zones. The concentrator, roast-leach-electrowinning, and vat-leach pilot plants operated successfully during the year and provided data for engineering design of the commercial plants scheduled for 1975 production. Design capacity is 69,000 tons per year of copper, 31,000 tons as cathode and 38,000 tons as cement copper. The yearend ore reserve estimate was 470 million tons averaging 0.75% copper.

UV Industries Inc. operated their Continental mine near Bayard, N. Mex., and milled approximately 875,000 tons of copper ore. The company completed a mill expansion project during the year bringing total milling capacity to 7,500 tons per day.

Smelter Production.—Output of copper at primary smelters in the United States was 1.76 million tons, a 12% increase from the strike-curtailed output of the previous year and a new record high quantity. The record high output was achieved despite some disruptions to production including curtailment of operations at several smelters to maintain required air quality standards during periods of adverse meteorological conditions.

Asarco's three copper smelters were not able to operate at full capacity, principally due to curtailment of production for air quality control purposes, and to a smaller degree, to shortages of natural gas during severe winter weather. Also, major breakdowns of air compressor equipment at the Hayden smelter caused a production cutback of approximately 30% for 3 months. New sulfuric acid plants were brought into operation at the Hayden and El Paso smelters and a 200-ton-per-day liquid sulfur dioxide plant was scheduled for completion in late 1973 at the Tacoma smelter. Upon completion of the Tacoma project, more than 50% of the sulfur input to the three smelters will be recovered. The quality of the ambient air will be further improved at Hayden by construction in 1973 of a 1,000-foot stack and installation of a new "closed loop" sulfur dioxide monitoring system similar to the systems now operating at the Tacoma and El Paso plants.

Anaconda's smelter renovation program, to improve environmental conditions and increase capacity from 30 to 35 million pounds of copper per month continued towards the scheduled second-quarter-1973 completion date. Kennecott awarded contracts for construction of converter hoods, ductwork, an electrostatic precipitator, and an acid plant at the Hurley, N. Mex., smelter; the company installed a fourth converter and made plans for constructing a 750-foot stack to disperse emissions at the McGill, Nev., smelter.

Phelps Dodge began construction of a new smelter in Hidalgo County, N. Mex., in order to have smelter capacity available for Tyrone concentrate when the Morenci smelter will be required to process the new Metcalf concentrate. The company was also constructing emissions control facilities including new acid plants at their Ajo and Morenci, Ariz., smelters.

Magma Copper Co. experienced some output restrictions at its San Manuel smelter owing to startup problems with the reverberatory furnace, the converter hoods, and a new automatic anode casting wheel installed during the recent expansion program. Magma is proceeding with construction of a $30 million converter gas collection and cooling system and a sulfuric acid plant, which, in conjunction with an air monitoring system, is expected to achieve required ambient air quality standards.

Inspiration Consolidated Copper Co. continued work on a $50 million construction program to replace much of the existing smelter at Miami, Ariz. The program, scheduled for completion in 1973, will replace the existing reverberatory furnace with an electric furnace, the present converters with new siphon-type converters, and provide new sulfuric acid production facilities.

White Pine Copper Co. operated a slag recovery plant from May through December that treated 560,000 tons of slag and recovered more than 3 million pounds of copper for return to the smelter compared with the total 1972 smelter output of 140 million pounds of copper.

Refinery Production.—Production of refined copper from primary materials was 1.87 million tons, a record high and 6% above the previous high of 1970. Refined copper produced from scrap was 423,200 tons compared with 400,700 tons in 1971. Total production of refined copper in the United States was 2.29 million tons, derived 81% from primary and 19% from scrap sources.

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.
M.C.S. Corp	Baltimore, Md.
Phelps Dodge Refining Corp	Laurel Hill, N.Y.
	El Paso, Tex.
Van Waters & Rogers Inc	Wallace, Idaho.
	Midvale, Utah.
	Metaline Falls, Wash.

Copper sulfate production increased 10% to 38,050 tons, a partial recovery from the 1971 slump to the smallest quantity since 1935. Shipments were slightly less than production and ending stocks were 5,800 tons. Of the total 37,960 tons shipped, producers' reports indicated that 14,030 tons was for agricultural uses, 22,400 tons was for industrial uses, and 1,530 tons was for other uses.

Byproduct Sulfuric Acid.—Sulfuric acid was produced at six copper smelters from the sulfur contained in offgases, and output increased for the fifth consecutive year from 803,300 to a record high of 1,010,600 tons, on a 100% acid basis. Facilities for sulfuric acid production were placed in operation late in the year at the El Paso, Tex., smelter of Asarco. New sulfuric acid plants were under construction or in an advanced planning stage at copper smelters at Ajo, Ariz., Anaconda, Mont., Hurley, N. Mex., Miami, Ariz., Morenci, Ariz., McGill, Nev., and San Manuel, Ariz.

SECONDARY COPPER AND BRASS

Domestic recovery of copper in all forms from all classes of purchased scrap totaled 1.30 million tons in 1972, an 8% increase from the 1971 total and the largest quantity since 1969. Recovery from copper-base scrap increased from 1.18 to 1.28 million tons. Brass mills accounted for 44% of the recovered copper, primary producers for 28%, and secondary smelters for 23%. The remaining 5% was reclaimed at chemical plants, foundries, and manufacturers.

Consumption of purchased copper-base scrap in 1972 was 1.8 million tons consisting of 62% new scrap and 38% old scrap. The major categories of brass mill products, refined copper, and brass and bronze ingots obtained from scrap all registered substantial increases.

CONSUMPTION

Consumption of refined copper rose 10% to 2.24 million tons. This was the largest quantity since the record high of 1966 and reflected the greater activity of the general economy. Most of the consumption was at wire mills, which increased 15% to 1.53 million tons. The brass mills used 667,000 tons of refined copper, 2% more than in 1971.

Apparent withdrawals of primary refined copper on domestic account was 1.90 million tons compared with 1.62 million tons in 1971.

STOCKS

Stocks of refined copper at primary producers increased from 75,000 to 91,000 tons during January then trended down to 57,000 tons by yearend. Fabricators' stocks of copper in all forms declined erratically from 511,000 tons at the start of the year to 460,000 tons by yearend.

PRICES

Domestic producer price quotations for wirebar copper increased 2¼ cents in February and decreased 2 cents in July for a yearend quotation of 50¼ to 50½ cents per pound. Average weighted prices for domestic copper deliveries in 1972 was 51.2 cents compared with 52.0 cents for those in 1971. Prices on the London Metal Exchange (LME) increased from an average of 48.8 cents per pound equivalent for January to 52.5 cents for March, then declined erratically to 45.6 cents for November, and increased to 46.3 cents for December. The 1972 average was 48.5 cents, unchanged from the 1971 average.

FOREIGN TRADE

U.S. exports of unmanufactured copper, excluding the category of ash and residues, first reported in 1972, decreased 7% to 226,300 tons. The largest category, refined copper, was 182,700 tons compared with 187,700 tons the preceding year. Exports of ore, concentrates, matte, and blister decreased from 36,800 tons in 1971 to 26,200 tons, and exports of copper scrap declined 5% to 17,400 tons.

U.S. imports of unmanufactured copper were 415,600 tons, an increase of 16% and the largest quantity since 1968. The largest increases were for refined copper, which advanced 17% to 192,400 tons, and for ore and concentrates, which rose from 30,800 to 53,700 tons. Blister copper was slightly higher at 157,400 tons. Of the total imports Canada supplied 36%, Peru 22%, and Chile 14%.

WORLD REVIEW

World mine production of copper attained 7.31 million tons, a record high for the fifth consecutive year with most major producing countries contributing to the increased output. A number of new mining projects, notably in Australia, Western Canada, Indonesia, the Republic of South Africa, and Zaïre came onstream during 1972.

The United States continued to lead the world in mine production with 23% of the total, followed by Canada, Chile, and Zambia each with 11%, and the U.S.S.R. and Zaire with 10% and 6%, respectively.

Argentina.—Cía. Minera Aguilar, S.A., Argentina subsidiary of St. Joe Minerals Corp., announced discovery of a large copper deposit at Pachon, in the Province of San Juan. Based on limited drilling the estimated reserves are 88 million tons of 1% copper and 65 million tons of 0.65% copper ore. An access road to the remote location is under construction to permit additional drilling and underground exploration.

Cities Service Co. discontinued exploration of a potential copper-molybdenum ore body in Catamarca Province because mineralization was considered subeconomic. However, evaluation of other mineral prospects in northwestern Argentina continued.

Australia.—Mine production of copper in Australia was 203,930 tons, an increase of 6%. Mount Isa Mines Ltd. (ISA), 53% owned by Asarco, increased output 16% to a record high 132,000 tons of blister copper for the fiscal year ended June 30, 1971, as its expansion program moved towards a mine-mill-smelter productive capacity of 170,000 tons per year by mid-1973. Exploration drilling increased ore reserves to 156 million tons containing 3.0% copper.

Mount Lyell Mining and Railway Co., Ltd., for the year ended June 30, 1972, produced a record high 24,000 tons of copper in concentrate from 2.7 million tons of ore mined and milled. The transition of production from open pit to underground operations was proceeding smoothly with 41% of production for the year from underground mining; an almost total transition was expected by September 1972. Reserves in all ore zones were estimated at 36 million tons of 1.48% copper for proven ore and 7 million tons of 1.47% copper for probable ore.

Bougainville Copper Pty., Ltd., began production in April, 3 months ahead of schedule, from its Panguna copper deposit on Bougainville Island in the Territory of Papua New Guinea. Output for 1972 was 136,700 tons of copper in concentrate derived from milling 2.1 million tons of ore averaging 0.78% copper. Initial mining was in an enriched, mixed oxide-sulfide portion of the deposit. This large copper development, consisting of an open pit mine, a 90,000-ton-per-day concentrator, two towns, port facilities, a power station, and other ancillary facilities became operational just 8 years after the start of exploration and 3 years after the commencement of production development. Annual rated productive capacity is 162,500 tons of copper in concentrate to be shipped to smelters in Japan, West Germany, and Spain. The project is based on a porphyry copper deposit calculated to contain approximately 1 billion tons of ore grading 0.48% copper and 0.02 ounce of gold per ton.

Botswana.—Bamangwato Concessions, Ltd. (BCL), owned 85% by Botswana Roan Selection Trust, Ltd. (BRST), and 15% by the Botswana Government, continued development of the Selebi-Pikwe nickel-copper mining project and its related infrastructure. The capital cost of the mining project is estimated at $143 million and the cost of the related infrastructure at $71 million. Production is expected to start by early 1974 at an initial annual rate of 17,000 tons of refined copper, 19,000 tons of refined nickel, and 140,000 tons of sulfur. The Pikwe deposit, which has a higher nickel content than the Selebi deposit, will be developed first. Mining facilities at Selebi are expected to be started in 1977 for initial production in 1979. Proven and probable reserves for the Selebi-Pikwe deposits are estimated to total 45.7 million tons grading 1.20% nickel and 1.26% copper.

Canada.—Production of copper in Canada increased 11% to 800,600 tons to achieve a record high for the third successive year. Ontario produced 36% of the total, followed by British Columbia, with 31%; Quebec, with 22%; Manitoba, with 7%; and the remaining Provinces, 4%.

Falconbridge Nickel Mines Ltd. operated nickel-copper mines and treatment plants in the Sudbury, Ontario, area at near capacity during 1972. Metal deliveries were 28,200 tons of copper compared to 30,500 tons in 1971. The decline was owing to a lower copper content of the ores mined and treated. Ore reserves at yearend were 93 million tons averaging 1.33% nickel and 0.67% copper. Falconbridge's Opemiska Div. during its first full year of expanded operations mined and milled 1,157,000 tons of 2.2% copper ore, compared with 1,074,000 tons of 2.3% copper ore in 1971. Ore reserves at yearend were 6.9 million tons with an average grade of 2.46% copper.

Ecstall Mining Ltd., a subsidiary of Texas Gulf, Inc., mined 3.6 million tons of ore from the copper-lead-zinc-silver Kidd Creek mine near Timmins, Ontario, which yielded 45,550 tons of copper in concentrates. The underground mine development is expected to supply 2,000 tons of ore per day by the end of 1973 and to be capable of providing the entire concentrator feed of 10,000 tons per day, as the open pit will be gradually phased out of operation over the next several years.

The International Nickel Co. of Canada Ltd. (INCO) mined 19 million tons of nickel-copper ore from 14 mines in Ontario and Manitoba compared with 28 million tons from 18 mines in 1971. The ores mined were selectively those with higher than average copper content consequently the copper output did not decline as much as indicated by the curtailed ore production. Copper deliveries from the Copper Cliff refinery were 154,090 tons compared with the record high 170,150 tons in 1971. A plant constructed to process residues from the nickel refinery will recover electrolytic copper and has an annual rated capacity of 15,000 tons of copper. At yearend INCO estimated that proven ore reserves were 389 million tons containing 4 million tons of copper.

Noranda Mines Ltd. operated the Horne mine in Quebec, mining 690,000 tons of ore averaging 2.28% copper and 0.162 ounce of gold per ton. The mill recovered 95,000 tons of copper concentrate and 142,000 tons of pyrite concentrate. Sulfide ore reserves at yearend were 1.1 million tons grading 2.11% copper, sufficient to maintain production until June 1974. The company's Geco mine produced a record 1.8 million tons of copper-zinc-silver ore averaging 2.12% copper which yielded 36,000 tons of copper in concentrates. Noranda's smelter achieved a record high production of 236,000 tons of anode copper from smelting their own and custom concentrates. The $19 million construction program for the Noranda Continuous Smelting Process prototype, designed to treat 800 tons of copper concentrate per day, will be completed by March 1973.

Gaspé Copper Mines Ltd. operated the Needle Mountain and Copper Mountain mines and associated mills and smelter near Murdochville, Quebec. The Needle Mountain mine produced 17,500 tons of copper in concentrate from milling 1.6 million tons of ore averaging 1.17% copper. The Copper Mountain mine produced 15,700 tons of copper from milling 2.4 million tons of 0.78% copper. Feed to the smelter consisted of 236,800 tons from the Gaspé operation and 118,000 tons from custom sources for production of 63,800 tons of copper in anodes. A $108 million mine-mill-smelter expansion project was under construction with completion scheduled during 1973. The new facilities will triple the mining-concentrating capacity to 34,000 tons per day of sulfide ore, which will more than double the present output of copper in concentrate. In addition, leaching facilities for treatment of 5,000 tons per day of low-grade oxide ores will be built. The smelter expansion will add 27,000 tons per year of blister copper capacity and a sulfuric acid plant with a rated annual output of 300,000 tons, about half to be used in the copper-leaching operation.

Madeleine Mines, Ltd., operated their Quebec copper mine after the February 12 settlement of a labor strike. During the period of operations the mill treated 730,000 tons of 1.42% copper ore which yielded 9,725 tons of copper in concentrate. Development during the year included sinking a shaft to facilitate mining deeper sections of the reserves and provide access for further exploration. Reserves at yearend were 4.4 million tons with an average 1.17% copper content.

Hudson Bay Mining & Smelting Co., Ltd., milled 1.8 million tons of ore and produced 54,076 tons of refined copper. The refined copper output was double the

1971 quantity when operations were closed by a strike of 5 months duration. The company operated 10 mines along the Manitoba-Saskatchewan boundary, including the White Lake and the Ghost Lake copper-zinc-silver mines, which were brought into production in 1972, and the Flexar mine, which was closed in October when reserves were depleted. Total ore reserves at yearend were 17 million tons with an average grade of 2.95% copper, 3.3% zinc, and 0.57 ounce of silver per ton.

Sheritt-Gordon Mines Ltd. continued operation of the Fox and Lynn Lake mines in Manitoba. Combined output for the year was 20,500 tons of copper contained in concentrates, a nearly one-third reduction from the record high of 1971. The curtailed output was a result of difficulties encountered in mining a pillar of high-grade ore in the Fox mine. Reserves at the Fox property were estimated at 13.3 million tons averaging 2.01% copper and 2.23% zinc. Owing to changing ore characteristics and mining costs the company decided not to publish reserves for Lynn Lake until a study in progress is completed. Development of the Ruttan Lake property continued with initial production at an annual rate of 3.5 million tons of ore scheduled during the second quarter of 1973. Reserves were 51 million tons grading 1.47% copper and 1.61% zinc.

During the second full year of operation the mine of Granduc Operating Co. north of Stewart, British Columbia, produced 27,000 tons of copper in concentrate from 2.1 million tons of 1.35% copper ore. Operating and manpower problems continued to hamper output and the planned production rate of 7,000 tons of ore per day was not achieved until late in the year. Ore reserves at yearend were 39 million tons averaging 1.67% copper.

Similkameen Mining Co. Ltd., a subsidiary of Newmont Mining Corp., completed construction of mining facilities near Princeton, British Columbia. The project, which cost $71 million, began milling of ore from the open pit mine in April and reached the rated capacity of 15,000 tons per day by mid-August. Output for the year was 11,350 tons of copper in concentrate from milling 3.0 million tons of 0.44% copper ore. Ore reserves were estimated at 72 million tons averaging 0.53% copper.

Utah International Inc. shipped approximately 32,500 tons of copper in concentrates during the first full year of operation at their Island Copper mine on the northern end of Vancouver Island. The mill design capacity of 33,000 tons per day was not achieved, owing principally to unexpected ore characteristics that adversely affected the capacity of the autogenous grinding mills. Ore reserves are estimated at 280 million tons containing 0.52% copper and 0.025% molybdenum.

Anaconda Britannia Mines Ltd. produced 9,500 tons of copper in concentrate at their mine in British Columbia compared with 8,300 tons in 1971. The increased output was related to new development work completed in 1970, which increased the rated annual productive capacity to 10,000 tons of copper.

Brenda Mines Ltd. delivered 9.5 million tons of ore to the concentrator averaging 0.21% copper and 0.06% molybdenum. Metal recoveries in concentrates were 90% for copper and 86% for molybdenum. An additional 3.3 million tons of low-grade ore was stockpiled for future treatment and 5.9 million tons of waste was stripped from the deposit.

Bethlehem Copper Corp. Ltd. mined approximately 6 million tons of 0.54% copper ore from the Jersey and Huestis open pit mines at Highland Valley, British Columbia, and produced concentrates containing 29,100 tons of copper. In November, mining of the Jersey ore body reached design limits and mining was discontinued. Plans are being formulated to develop the J-A ore body 2 miles south of the operating mines, containing an estimated 300 million tons of copper-molybdenum ore with an average grade of about 0.45% copper equivalent. Reserves for the presently operated property are 39 million tons of 0.56% copper, for the Lake zone project 190 million tons of 0.48% copper, and for the Maggie ore zone at least 200 million tons of 0.40% copper equivalent.

Lornex Mining Corporation Ltd. began commercial production on October 1 at their large, low-grade copper-molybdenum property in the Highland Valley of British Columbia. The mill has a rated capacity of 38,000 tons of ore per day, which is calculated to yield 55,000 tons of copper in concentrate annually. Ore reserves are estimated to be 293 million tons with an average grade of 0.427% copper and 0.014% molybdenum.

Gibralter Mines Ltd. commenced operations at their copper-molybdenum deposit in the Cariboo District of British Columbia in March and the mill treated a total of 11.2 million tons of ore at an average grade of 0.46% copper which yielded a total of 41,000 tons of copper in concentrate. The rated 30,000-ton-per-day capacity of the concentrator was quickly achieved and after April 1 averaged 39,500 tons. Copper recovery, at 80.4%, was adversely affected by the oxide copper content of the ore being mined. A total of 26.4 million tons of ore, waste, and overburden or an average rate of 77,300 tons per day was moved. Studies indicated the daily rate should be increased to 120,000 tons to balance maximum concentrator capacity and equipment was being acquired toward that goal. At yearend the minable ore reserves, at a cutoff grade of 0.25% copper, were estimated at 347 million tons grading 0.37% copper.

Craigmont Mines Ltd. in the fiscal year ended October 31, 1972, produced 23,600 tons of copper in concentrate from 1.9 million tons of ore containing 1.34% copper from their mine near Merritt, British Columbia. Average production from the sublevel caving operation was a record high of 4,850 tons per day. Ore reserves, at a cutoff grade of 0.7% copper, are estimated at 10.3 million tons grading 1.77% copper.

Bell Copper Co. initiated production in October at their Babine Lake, British Columbia, property. Open pit mining consisted of 2.5 million tons of stripping, 0.9 million tons of low-grade ore stockpiled for future treatment, and 1.2 million tons of ore averaging 0.71% copper for delivery to the concentrator. The concentrator, with a rated capacity of 10,000 tons per day, averaged 9,200 tons during the startup period and produced 15,400 tons of concentrate containing 4,150 tons of copper with an average 82.5% copper recovery.

Coast Copper Co., Ltd., suspended operations at its Benson Lake mine on Northern Vancouver Island in November because of rising costs and unsatisfactory market conditions. During the 10 years of operations 2.8 million tons of ore were mined to produce 157,000 tons of copper concentrate.

Chile.—Litigation concerning the amount of compensation to be paid to the former owners of copper mines that were nationalized in 1971 continued throughout the year. Appeals by The Anaconda Company and Kennecott Copper Corp. asking compensation for their equities in the expropriated Chuquicamata, El Salvador, and El Teniente properties were rejected by the Chilean Copper Tribunal in August. Kennecott has initiated actions to contest the terms of the expropriation in the courts of several other countries. The amount due Cerro Corp. for its equity in the Andina property was set by the Copper Tribunal and negotiations were in progress to set the time and terms of payment. Anaconda and Kennecott began litigation with the State-owned Chilean copper company (Corporation Del Cobre) in Chilean and United States courts with regards to the enforcibility of promissory notes, now in default, that were given by Chile to Kennecott in 1967 and to Anaconda in 1969 for 51% interest in the El Teniente, Chuquicamata and El Salvador properties. The Overseas Private Investment Corp. (OPIC) purchased notes guaranteed by Chile and issued to Kennecott to help finance development of the El Teniente mine. Claims by Anaconda to OPIC for insurance payment of the $159 million in defaulted notes were refused and the claims have been submitted to binding arbitration as provided in the insurance contract.

Copper production was an estimated 798,900 tons, up 1% from that of 1971. Production from the large mines was as follows: Chuquicamata, 258,600 tons compared with 274,000 in 1971; El Teniente, about 200,000 tons compared with 155,000; El Salvador, 93,300 tons compared with 92,000; Exótica, 34,400 tons compared with 39,000; and Andina, 59,400 tons compared with 58,200.

Large plant expansions made immediately prior to nationalization failed to significantly increase production because of resignations of supervisory and technical personnel and shortages of equipment, repair parts, and supplies.

Production began from the Sagasca property late in 1972 with about 5,500 tons of copper in precipitate being shipped. The smelter treating El Teniente concentrates is being enlarged to 310,000 tons of copper per year by the addition of a new reverberatory furnace scheduled for completion in 1973. Studies were made of the Exótica vat-leaching plant where output has remained far below design capacity owing to unexpectedly large quantities of impurities in the leach solution. A decision was reached to add a solvent extraction circuit to provide clear solution for electrowinning. Construction was begun on a subsmelter in Vallenar with completion expected in 1973. The matte produced will be shipped to other smelters for conversion into blister copper.

Colombia.—The Colombian Government announced discovery of a copper deposit in the Department of Antioquia near the border of the Department of Chocó. The discovery was a direct outgrowth of assistance to the Colombian Governmant by the U.S. Agency for International Development (AID). In the preliminary report the deposit is estimated at 625 million tons with an average grade of 0.7% copper. Further exploration and a feasibility study will be required to determine the economic significance of the discovery.

Cyprus.—The Cyprus Island Div. of Cyprus Mines Corp. operated open pit mines at Lefka and Skouriotissa and a pressure-leach plant for reprocessing of mill tailings. Output of copper contained in concentrates and precipitates totaled about 9,750 tons. Milled ore averaged 1.3% copper but reserves of this grade were nearly exhausted. However, a deposit of lower grade (0.9% copper) in the Skouriotissa area with reserves estimated to extend the life of the mining operations about 5 years is under development.

Finland.—Copper output increased 23% to 38,400 tons. Principal producing mines were the Outokumpu with 19,600 tons, the Pyhasalmi with 5,300 tons, the Vihanti with 3,000 tons, and the Virtasalmi with 2,300 tons.

Indonesia.—Freeport Indonesia Inc., a subsidiary of Freeport Minerals Co., completed development of the 11,500-foot-altitude Ertsberg copper deposit in West Irian and initial production began late in 1972. The $150 million project is designed to operate at an annual production rate of 2.5 million tons of ore yielding about 65,000 tons of copper in concentrate plus recoverable quantities of gold and silver. Proven reserves are 33 million tons of ore averaging 2.5% copper, and 0.025 ounce gold and 0.265 ounce silver per ton. There are surface indications of additional mineralization in the vicinity of the Ertsberg deposit which will be explored.

Iran.—Sar Cheshmeh Copper Mining Co., an Iranian Government-owned company, signed a technical assistance agreement with The Anaconda Company for services to develop a $400 million copper mine and metallurgical complex in southern Iran. The operation will produce approximately 145,000 tons of copper per year about 4 years after the start of construction. Reserves upon which the project is based are 400 million tons averaging 1.12% copper. Substantial reserves of somewhat lower grade ore are indicated to exist in the area.

Malaysia.—The Mamut Mines Development Co., a consortium of Japanese firms in a joint venture with the Sabah Government and other Malaysian interests, continued development of a copper deposit near Mamut, Sabah. Production is scheduled for early 1975 at the rate of 18,000 tons of ore per day. Reserves are given as 80 million tons averaging 0.6% copper.

Mauritania.—Société Minière de Mauritanie (SOMIMA), 33.5% owned by Charter Consolidated Ltd., continued to experience delays in bringing their mine at Akjoujt into production. Output of the oxide ore deposit, minable by open pit methods, is concentrated in a plant using the Torco segregation process developed by the Anglo American Corp. of South Africa group. Design capacity of the plant is 30,000 tons of copper per year. The process has been satisfactorily demonstrated but the selected equipment requires extensive modification due to the difficult nature of the ore and the stresses of the desert climatic conditions.

Mexico.—Asarco Mexicana, S.A., increased the output of blister copper 42% to 36,000 tons. The gain was largely due to the first full year of operation of the Inguarán mine in the State of Michoacán. The company began construction of a new 45,000-ton-per-year refinery at San Luis Potosi. Cía. Mexicana de Cobre, S.A., 49% owned by Asarco Mexicana, continued studies relating to financing and development of a porphyry copper deposit at the La Caridad propety near Nacozari in the State of Sonora.

Compañía Minera Nacozari, S.A., operated the Cananea mine and smelter to produce 44,574 tons of blister and refined copper, an 11% increase. An expansion program in progress is expected to increase output each year until attainment of 70,000 tons in 1976.

Panamá.—Canadian Javelin Ltd. announced that the Cerro Colorado exploration project in western Panamá indicated a major porphyry copper deposit in excess of 1 billion tons averaging 0.6 to 0.7% copper. Feasibility studies to develop the ore body are in progress. The Cerro Colorado deposit is located about 90 miles west of the Petaquilla deposit, discovered in 1968 by a United Nations technical mission and estimated to contain from 200 to 300 million tons averaging 0.6% copper.

Peru.—Production of Southern Peru Copper Corp., in terms of blister copper produced and export of copper in concentrates, was 148,300 tons compared with 141,200 tons in 1971. Approximately 40,000 tons of concentrate production from the Toquepala mine was exported owing to curtailment of production at the Ilo smelter, which lost 43 work days by strikes. Cerro Corp. operations were relatively free of work interruptions and production inceased 16% to 52,130 tons of copper at its La Oroya smelter, with 39% of the output from purchased ores.

Minero Peru, a Peruvian Government entity, and the Japanese Mitsui Furukawa Group signed a contract for construction of a copper refinery at Ilo. The facility, scheduled for operation in 1975, will have a capacity of 150,000 tons of electrolytic copper per year. A letter of intent was signed by Minero Peru and a consortium of five Japanese companies to conduct a $2 million feasibility study for exploitation of the Michiquillay copper deposit in the Department of Cajamarca. The deposit has ore reserves estimated at 620 million tons grading 0.72% copper. However, the isolated location and a lack of basic infrastructures such as roads and electricity has been a deterrent to development of a viable operation. Minero Peru also announced discovery of a large porphyry copper deposit in the Department of Lambageque in northern Peru. This is the first significant discovery of copper in this area and preliminary exploration places the size between 50 and 300 million tons.

Development of the Cuajone mine by Southern Peru Copper Corp. continued during 1972 with expenditures of approximately $37 million, bringing the total investment at yearend to $83 million. Principal work accomplished during the year was the driving of 11,450 feet of railroad tunnel, removal of 20 million tons of overburden, and site preparation for the concentrator. A work plan was filed for expenditure or commitment of $48 million during 1973 as the next step in this $500 million project.

Compañía Minera del Madrigal, a subsidiary of Homestake Mining Co., brought the Madrigal copper-lead-zinc mine in southern Peru into operation in April. Output from the 500-ton-per-day mill and the ore grade during the first year of operation were below expectations. However, construction in progress is directed towards improving efficiency of production.

Philippines.—Twelve mining companies produced 226,000 tons of copper in concentrates and direct-shipping-grade ore, compared with 217,800 tons the previous year. Atlas Consolidated Mining & Development Corp., the largest copper producer in the Philippines, in the first full year of operation after completion of their mill expansion, increased output 14% to 88,700 tons of copper in concentrate. The second largest producer, Marcopper Mining Corp., produced 48,900 tons of copper from processing 7.6 million tons of ore containing 0.70% copper. Minable ore reserves are 118 million tons of 0.59% copper. Other major producing companies were Marinduque Mining and Industrial Corp., Lepanto Consolidated Mining Co., and Philex Mining Corp., with outputs of 34,700 tons, 28,600 tons, and 22,900 tons, respectively.

Poland.—A large expansion program at the Lubin and Polkowice mines and the associated smelter-refinery plants at Glogow and Legnica increased annual productive capacity to about 150,000 tons of copper. Continuation of the expansion program calls for development of a third large mine called Rudna, enlargement of the Glogow smelter-refinery and construction of a new refinery at Zukowice.

Rhodesia, Southern.—M.T.D. Mangula Ltd. during the year ending September 30, 1972, produced 18,800 tons of copper in concentrates and precipitates from the Mangula mine about 80 miles northwest of Salisbury. Concentrates containing 15,200 tons of copper were produced from milling 1.4 million tons of sulfide ore and precipitates containing 3,600 tons of copper were produced from treating 550,000 tons of an oxidized ore in the leach plant. Proved sulfide ore reserves are 15 million tons averaging 1.30% copper and oxidized ore reserves amount to 0.9 million tons of 0.75% oxide copper. Two new mines, Norah and Silverside, began operations near yearend. Proven sulfide ore reserves were 2.1 million tons of 1.30% copper at the Norah mine and 440,000 tons of 1.77% copper at the Silverside mine.

Lomagundi Smelting and Mining Ltd. produced 3,140 tons of copper in concentrates from mining and milling 330,000 tons of ore from the Alaska mine. The Shackleton mine yielded 10,050 tons of copper in concentrates from 570,000 tons of 1.90% copper ore. Reserves at yearend were 550,000 tons of 1.78% copper at the Alaska mine and 535,000 tons of 1.98% copper at the Shackleton mine.

Gwai River Mines Ltd. produced 2,500 tons of copper in concentrates from mining and milling 215,000 tons of 1.33% copper ore. Proved ore reserves were 130,000 tons of 1.31% copper.

South Africa, Republic of.—O'okiep Copper Co. Ltd. milled 3.5 million tons of ore with an average grade of 1.28% copper from eight producing mines, which yielded 40,700 tons of blister copper. Exploration increased reserves from 27.6 to 28.0 million tons of ore averaging 1.56% copper.

Palabora Mining Co. Ltd. increased output 12% to 110,200 tons of copper. Ore milled was 21.3 million tons of 0.56% copper compared with 21.0 million tons of 0.57% copper in 1971.

Messina (Transvaal) Development Co. mined and milled 1.2 million tons of 1.13% copper ore from the Messina mine, which yielded 12,100 tons of copper in concentrates. The tonnage of proved ore reserves remained little changed at 5.9 million tons but the grade improved from 1.38 to 1.44% copper.

Africa Triangle Mining Prospecting and Development Co., a holding company formed by Anglo-Vaal, Middle Witwatersrand, and United States Steel Corp., initiated production at their copper-zinc ore deposit near Prieska in northwestern Cape Province in late 1972, well ahead of schedule. It is anticipated that production will attain a rate of 110,000 tons of ore per month by early 1973 and increase to the planned rate of 250,000 tons per month during the second half of 1974. Proven reserves are estimated to be 25 million tons grading between 1.5 to 2.0% copper and about 3% zinc.

South-West Africa, Territory of.—The Tsumeb Corp. Ltd. operated the Tsumeb mine at a reduced level owing to first-quarter strikes; and quantity of ore milled was reduced 16% to 484,000 tons averaging 3.37% copper, 11.49% lead, and 3.20% zinc. The strike did not affect the Kombat mine and 416,000 tons of ore averaging 1.30% copper and 1.47% lead was mined and milled. The curtailed output at the Tsumeb mine and a lower copper content in ore milled at the Kombat mine was reflected in a reduction in blister copper produced at the smelter from 29,300 tons in 1971 to 28,800 tons in 1972. Yearend ore reserves were 5.8 million tons averaging 4.63% copper, 8.98% lead at the Tsumeb mine and 1.5 million tons averaging 1.96% copper and 3.11% lead at the Kombat mine.

Oamites Mining Co. Ltd., operated the Oamites mine for its first full year and produced 5,000 tons of copper in concentrate from milling 353,000 tons of 1.39% copper ore. A general labor strike in January and other startup problems hampered output but by yearend the rated capacity of 50,000 tons of ore per month was achieved.

Uganda.—In June the corporate income tax rate for mining companies was reduced from 40 to 22.5% and the copper export tax was abolished. Kilembe Mines, Ltd. 70% owned by Falconbridge Nickel Mines Ltd. (Canada) processed 90,700 tons of ore to produce 14,200 tons of blister copper compared with 17,300 tons in 1971. Ore reserves at yearend in the proven and probable category were estimated to be 6.2 million tons of 1.97% copper.

Zaire.—La Générale des Carrières et des Mines du Zaïre (Gécamines), the Government-owned mining company, increased copper output 6% to 473,000 tons. The greater output represents a step in an expansion program designed to increase Gécamines', annual copper producing capacity to 500,000 tons by 1974 and to 660,000 tons by 1980.

The joint Japanese-Congolese concern,

Société de Développement Industriel et Minier du Zaire (SODIMIZA) initiated production in October at the Mushoshi mine in Shaba Province. Designed capacity of the mine is 58,000 tons per year with a planned increase to 68,000 tons during 1976. Another mine at Tshinsenda is scheduled to be brought into production at a 68,000-ton-per-year rate during 1976. Ore reserves are estimated to be 110 million tons of 3.5% copper at Mushoshi and 35 million tons of 5.5% copper at Tshinsenda

Société Minière de Tenke-Fungurume (SMTF), a consortium of companies which includes Amoco Minerals Co., (subsidiary of Standard Oil Co. of Indiana), Charter Consolidated Ltd., and Leon Tempelsman & Son Inc., continued exploration work in their concession area of Shaba Province. SMTF announced reserves at the end of 1972 of 50 million tons with an average content of 5.5% copper and 0.44% cobalt. Plans are to construct a mining-milling-refining complex with the related infrastructure costing $300 million for production in 1977 at an annual rate of 150,000 tons of copper.

Zambia.—Copper production in 1972 was 790,500 tons compared with 718,300 tons in 1971.

Nchanga Consolidated Copper Mines Ltd. (NCCM), comprised of the Rokana, Chingola, and Konkola Divs., operated copper mines, a smelter, and a refinery. For the year ending March 31, 1972, output was 442,300 tons of refined copper, a modest increase in the rate of production from the preceding 15-month period. The target for the following year is 470,000 tons. At the Rokana Div. construction was in progress for a plant to treat mixed sulfide and oxide ores, a third acid plant, and installation of periodic current reversal in the tankhouse to increase capacity. At the Chingola Div. the leach precipitation plant was commissioned in October 1971 and was approaching the planned production rate of 2,200 tons of copper per month. The solvent extraction-ion exchange process plant was under construction with scheduled completion in 1974. Shaft sinking continued at Konkola but inflow of water continued to be a problem. Pumping capacity has been increased to 390,000 cubic meters a day and a further increase to 620,000 cubic meters is planned. Geological and metallurgical test work continued at Kansanshi in preparation for reopening of that mine in 1973.

Roan Consolidated Mines, Ltd. (RCM), comprised of the Mufulira, Chibuluma, Chambishi, Kalengwa, and Luanshya mines produced 268,000 tons of refined copper in the year ended June 30, 1972, compared with 270,000 tons produced the previous year. Rehabilitation of the Mufulira mine is proceeding on schedule but output remained at less than half that anticipated before the 1970 cave-in.

Luanshya production was lower than that of the previous year owing to lower ore grade and bad ground conditions. Development of the Baluba section continued with output at the rate of 24,000 tons of copper per year to commence in January 1973. Subsequent expansion is planned to increase this rate to about 60,000 tons as other sections of Luanshya are depleted. The increase in production at Chambishi from 33,000 to 38,000 tons was made possible by use of spare concentrator capacity at Mufulira. The development of underground mining at Chambishi is proceeding with output scheduled for late 1973 at an annual rate of 26,000 tons of copper. This rate is to be increased to 52,000 tons as open pit operations are gradually phased out. The completion of the extension to the Chambishi concentrater is scheduled for the second half of 1973.

TECHNOLOGY

Articles published on copper resources included results of research correlating the regional distribution of porphyry copper deposits to the developing concept of orogeny at the margins of drifting crustal plates; [2] the application of induced polarization and resistivity surveys in exploration for copper deposits; [3] and the potential

[2] Hodder, Robert W., and Victor F. Hollister. Structural Features of Porphyry Copper Deposits and the Tectonic Evolution of Continents. Canadian Min. and Met. Bull., v. 65, No. 718, February 1972, pp. 41–45.

[3] Cannon, Richard W., Jerry M. Thornton, and Don C. Rotherham. Induced Polarization and Resistivity in the Gilbraltar Area, British Columbia. Trans. Soc. Min. Eng., AIME, v. 252, No. 4, December 1972, pp. 392–397.

use of neutron activation analysis in qualitative logging for copper where coring is difficult.[4]

A soil sampling survey conducted on a 1-mile grid pattern, over a 400-square-mile area of central Utah, indicated that the discovered anomalies would have indicated exploration targets for most of the existing mining districts, but that some might have been overlooked.[5] Two papers described mineral occurrences of potential copper-producing districts in Colorado and Wyoming.[6]

Research has been conducted on the use of geophysical techniques to monitor slope stability in large open pit mines.[7] An article describes the operating parameters of the sublevel caving mining method and the application of this method to a copper deposit characterized as a steeply dipping vein surrounded by incompetent rock.[8]

A design study on construction of a hypothetical copper concentrator for a typical southwestern United States location concluded that incorporation of functional design, large equipment, and outdoor type of construction could result in substantial savings when compared with the cost of conventional designs.[9]

Several review articles on copper metallurgy were published; [10] they included descriptions of flash smelting and of the continuous smelting processes under development in Australia, Canada, and Japan. A more detailed description [11] is given of a continuous smelting process for a semicommercial (20,000 tons per year) prototype plant placed in operation in November 1971.

The Smelter Control Research Association (SCRA) has reviewed its own and the utility industry experience with lime and limestone scrubbing systems for removal of sulfur from stack emissions.[12] It was concluded that the use of scrubbing systems could be effective but that considerable research and development will be required for design of commercial-scale units. Another article [13] reviewed research on the choice of refractory materials for reverberatory furnace construction, considering factors of structural strength and thermal shock, and corrosion requirements.

An article [14] described a 90,000-ton-per-year Japanese smelter commissioned in January 1972 that uses the flash smelting process. The facility is claimed to be efficient in the poduction of copper and permits control of sulfur emissions to levels well within the stringent air quality standards. Some of the new copper smelting processes require copper recovery from the converter slag to achieve acceptable overall efficiency, and research has been conducted in that area.[15]

Three types of X-ray analytical instrumentation were tested in their application for rapid identification in sorting scrap metals and for quantitative analysis to provide guidance in the melting and casting of alloys.[16]

Development and use of an electromotive force electrolyte probe which reliably monitors the oxygen content during the

---

[4] Hoyer, W. A., and G. A. Lock. Logging for Copper by In-Situ Neutron Activation Analysis. Trans. Soc. Min. Eng., AIME, v. 252, No. 4, December 1972, pp. 409–417.

[5] Beers, Armond H., W. T. Parry, and M. P. Nackowski. Trace Element Analysis of Oquirrh Mountain Soils. Trans. Soc. Min. Eng., AIME, v. 252, No. 4, December 1972, pp. 443–447.

[6] Bromfield, C. S., and F. E. Williams. Mineral Resources of the Wilson Mountains Primitive Area, Colo. With a section on Geophysical interpretation by Peter Popenoe. U.S. Geol. Surv. Bull. 1353–A, 1972, pp. a1–a79.

Fisher, F. S. Tertiary Mineralization and Hydrothermal Alteration in the Stinkingwater Mining Region, Park County, Wyo. U.S. Geol. Surv. Bull. 1332–c, 1972, pp. c1–c33.

[7] McCarter, M. K., and K. C. Ko. Seismic Refraction Technique for Delineating Unstable Areas in Pit Slopes. Trans. Soc. Min. Eng., AIME, v. 252, No. 4, December 1972, pp. 374–378.

[8] Sandstrom, P.O. Application and Optimization of Sublevel Caving Techniques. Eng. and Min. J., v. 173, No. 6, June 1972, pp. 112–125.

[9] Shoemaker, Robert S., and Allan D. Taylor. Mill Design for the Seventies. Trans. Soc. Min. Eng., AIME, v. 252, No. 2, June 1972, pp. 131–136.

[10] Engineering and Mining Journal. What's Happening in Copper Metallurgy. V. 173, No. 2, February 1972, pp. 75–79.

Treilhard, D. G. Economic and Metallurgical Change in Copper Smelter Design. Western Miner, v. 45, No. 5, May 1972, pp. 34–47.

Engineering and Mining Journal. Copper Smelters Strive for Modernization. V. 173, No. 6, June 1972, pp. 170–171.

[11] Engineering and Mining Journal. Mitsubishi's Continuous Copper Smelting Process Goes On Stream. V. 173, No. 8, August 1972, pp. 66–68.

[12] Campbell, Dr. Ivor E., and John D. Ireland. Status Report on Lime or Wet Limestone Scrubbing to Control SO_2 in Stack Gas. Eng. and Min. J., v. 173, No. 12, December 1972, pp. 78–85.

[13] Renkey, A. L., and T. F. Soroka. Roofs for Reverberatory Smelters. J. Metals, v. 24, No. 6, June 1972, pp. 18–22.

[14] Mealey, Mike. Japan's Tamano Copper Smelter: The Most Modern in the World. Eng. and Min. J., v. 173, No. 6, June 1972, pp. 130–131.

[15] Subramanian, K. N., and N. J. Themelis. Copper Recovery by Flotation. J. Metals, v. 24, No. 4, April 1972, pp. 33–38.

[16] Campbell, William J., and Harold E. Marr III. Identification and Analyses of Copper-Base Alloys by Fluorescent X-Ray Spectrography. BuMines RI 7635, 1972, 30 pp.

casting of refined copper was described.[17] Control of oxygen during casting is vitally important to obtain the desired physical properties of refined copper.

Research related to copper hydrometallurgy included: development of an electrochemical process employing a ferric chloride leach in a hot acidic environment followed by electrolysis and precipitation steps to produce copper, iron, and elemental sulfur;[18] development of a process to produce pure copper powder through roasting, ammoniacal leaching, distillation to the oxide, blending with prepared copper sulfide, chloridization, and then reduction;[19] the selective stripping of a high-purity copper sulfate solution suitable for electrolysis from a copper-nickel-cobalt ammoniacal leach solution;[20] the determination of mineral leaching rates and sulfate formation rates during oxygen pressure leaching in the temperature range straddling the melting point of sulfur;[21] and the discovery of a strain of bacteria with optimum activity in the vicinity of 60°C and capable of oxidizing sulfur and iron compounds that may improve leaching efficiency of chalcopyrite at the temperatures reached in the interior of copper waste dumps.[22]

A report was published on a study considering mutual substitutability of aluminum and copper in electrical, heat exchange, and other applications.[23] Several articles described properties and applications of wrought copper and copper alloys.[24] Research to produce beryllium-copper alloys by electrodeposition of beryllium on liquid copper cathodes was generally unsuccessful.[25]

Table 3.—Copper produced from domestic ores, by source

(Thousand short tons)

Year	Mine	Smelter	Refinery
1968	1,205	1,235	1,161
1969	1,545	1,547	1,469
1970	1,720	1,605	1,521
1971	1,522	1,471	1,411
1972	1,665	1,649	1,680

Table 4.—Copper ore and recoverable copper produced, by mining method

(Percent)

Year	Open pit		Underground	
	Ore	Copper[1]	Ore	Copper[2]
1968	87	82	13	18
1969	88	84	12	16
1970	89	84	11	16
1971	88	82	12	18
1972	85	80	15	20

[1] Includes copper from dump leaching.
[2] Includes copper from in-place leaching.

Table 5.—Mine production of recoverable copper in the United States, by month

(Short tons)

Month	1971	1972
January	137,479	131,306
February	130,561	140,106
March	141,802	147,458
April	141,019	140,714
May	145,215	144,623
June	149,248	137,566
July	49,155	123,176
August	105,595	141,714
September	115,142	139,410
October	135,264	140,640
November	136,830	136,597
December	134,873	141,530
Total	1,522,183	1,664,840

[17] Dompas, J. M., and P. C. Lockyer. Oxygen Control in Liquid Copper by the Oxycell. Met. Trans., v. 3, No. 10, October 1972, pp. 2597–2604.
[18] Kruesi, P. R., E. S. Allen, and J. L. Lake. Inventor, Developers Explain How New Cyment Process Works. Pay Dirt, No. 400, Oct. 23, 1972, pp. 4–10.
[19] McFarland, C. M., and R. E. Cech. Copper Recovery Via Sulfide-Salt Reduction. J. Metals, v. 24, No. 10, October 1972, pp. 20–29.
[20] Ritcey, G. M., and B. H. Lucas. Separation of Copper From Nickel and Cobalt by Liquid-Liquid Extraction From Ammoniacal Solutions. Canadian Min. and Met. Bull., v. 65, No. 721, May 1972, pp. 46–49.
[21] Peters, E., and F. Loewen. Pressure Leaching of Copper Minerals in Perchloric Acid Solutions. Met. Trans., v. 4, No. 1, January 1973, pp. 5–14.
[22] Science. Leaching: Use of a Thermophilic and Chemoautotrophic Microbe. V. 179, No. 4072, Feb. 2, 1973, pp. 488–490.
[23] National Materials Advisory Board. Mutual Substitutability of Aluminum and Copper. Nat. Acad. Sci.—Nat. Acad. Eng. Washington, D.C., NMAB–286, April 1972, 186 pp.
[24] France, Walter D., and Delmar E. Trout. Selecting Copper Alloys for Fatigue Applications. Metal Progress, v. 101, No. 6, June 1972, pp. 69–72.
Metal Progress. Properties and Applications of Widely Used Wrought Coppers and Copper Alloys. V. 103, No. 2, February 1973, pp. 66–72.
———. Compositions and Applications of Supplementary Wrought Coppers and Copper Alloys. V. 103, No. 2, February 1973, pp. 73–74.
[25] Kirby, D. E., D. A. O'Keefe, and T. A. Sullivan. Electrolytic Preparation of Beryllium-Copper Alloys. BuMines RI 7629, 1972, 14 pp.

Table 6.—Mine production of recoverable copper in the United States, by State

(Short tons)

State	1968	1969	1970	1971	1972
Arizona	627,961	801,363	917,918	820,171	908,612
California	1,182	1,129	2,308	515	598
Colorado	3,451	3,598	3,749	3,938	3,944
Idaho	3,525	3,332	3,612	3,776	2,942
Maine	898	1,320	2,703	2,510	1,220
Michigan	74,805	75,226	67,543	56,005	67,260
Missouri	5,494	12,664	12,134	8,445	11,509
Montana	69,480	103,314	120,412	88,581	123,110
Nevada	77,213	104,924	106,688	96,928	101,119
New Mexico	90,769	119,956	166,278	157,419	168,034
Pennsylvania	4,850	3,382	2,539	3,349	2,611
Tennessee	14,196	15,353	15,535	13,916	11,310
Utah	228,245	296,699	295,738	263,451	259,507
Other States [1]	2,552	2,319	2,500	3,179	3,064
Total	1,204,621	1,544,579	1,719,657	1,522,183	1,664,840

[1] Includes Alaska, Oklahoma, Oregon, Washington, and Wyoming.

Table 7.—Twenty-five leading copper-producing mines in the United States in 1972, 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, gold-silver ore.
2	San Manuel	Pinal, Ariz	Magma Copper Co	Copper ore.
3	Morenci	Greenlee, Ariz	Phelps Dodge Corp	Copper ore and copper precipitates.
4	Berkeley Pit	Silver Bow, Mont	The Anaconda Company	Do.
5	Ray Pit	Pinal, Ariz	Kennecott Copper Corp	Do.
6	Pima	Pima, Ariz	Pima Mining Co	Copper ore.
7	Tyrone	Grant, N. Mex	Phelps Dodge Corp	Copper ore and copper precipitates.
8	Twin Buttes	Pima, Ariz	The Anaconda Company	Copper ore.
9	Sierrita	do	Duval Sierrita Corp	Do.
10	White Pine	Ontonagon, Mich	White Pine Copper Co	Do.
11	Chino	Grant, N. Mex	Kennecott Copper Corp	Copper ore and copper precipitates.
12	New Cornelia	Pima, Ariz	Phelps Dodge Corp	Copper, gold-silver ores.
13	Inspiration	Gila, Ariz	Inspiration Consolidated Copper Co.	Copper ore and copper precipitates.
14	Mission	Pima, Ariz	American Smelting and Refining Co.	Copper ore.
15	Ruth Pit	White Pine, Nev	Kennecott Copper Corp	Do.
16	Yerington	Lyon, Nev	The Anaconda Company	Copper ore and copper precipitates.
17	Copper Queen	Cochise, Ariz	Phelps Dodge Corp	Copper ore.
18	Mineral Park	Mohave, Ariz	Duval Corp	Copper ore and copper precipitates.
19	Copper Cities	Gila, Ariz	Cities Service Co	Do.
20	Silver Bell	Pima, Ariz	American Smelting and Refining Co.	Do.
21	Butte Hill	Silver Bow, Mont	The Anaconda Company	Do.
22	Lavender Pit	Cochise, Ariz	Phelps Dodge Corp	Do.
23	Bagdad	Yavapai, Ariz	Bagdad Copper Corp	Copper ore.
24	Magma	Pinal, Ariz	Magma Copper Co	Do.
25	Copper Canyon	Lander, Nev	Duval Corp	Copper ore and copper precipitates.

Table 8.—Mine production of recoverable copper in 1972, by method of treatment

Method of treatment	Ore treated (thousand short tons)	Recoverable copper		Remarks
		Thousand pounds	Percent yield	
Copper ore:				
By concentration	248,663	2,740,883	0.55	See table 10.
By smelting	484	16,260	1.68	See table 11.
By leaching	17,684	[1] 164,984	.47	See table 12.
	266,831	2,922,127	.55	
Dump and in-place leaching	--	341,986	--	See table 12.
Miscellaneous from cleanup, tailings, and noncopper ores	--	65,567	--	--
Total	XX	3,329,680	XX	--

XX Not applicable.
[1] Includes 63,280,704 pounds of electrowon copper.

Table 9.—Copper ore shipped directly to smelters or concentrated in the United States, by State in 1972, with copper, gold, and silver content in terms of recoverable metal

State	Ore shipped or concentrated (thousand short tons)	Recoverable metal content				Value of gold and silver per ton of ore
		Copper		Gold (troy ounces)	Silver (troy ounces)	
		Thousand pounds	Percent			
Arizona	153,587	1,573,868	0.51	102,236	6,553,533	$0.11
Colorado	4	216	2.70	205	3,331	4.65
Idaho	20	558	1.40	66	18,648	1.79
Michigan	8,250	134,473	.82	--	785,100	.16
Montana	17,127	188,669	.55	22,335	3,089,647	.38
Nevada	13,289	143,619	.54	34,771	592,508	.23
New Mexico	19,929	279,079	.70	11,351	840,879	.10
Tennessee [1]	1,762	22,619	.64	176	83,466	.09
Utah	34,952	407,942	.58	313,412	2,654,690	.65
Other States	229	6.101	1.33	--	33,970	.25
Total	249,147	2,757,144	.55	484,552	14,655,772	.21

[1] Copper-zinc ore.

Table 10.—Copper ore concentrated [1] in the United States, by State in 1972, with content in terms of recoverable copper

State	Ore concentrated (thousand short tons)	Recoverable copper content	
		Thousand pounds	Percent
Arizona	153,250	1,560,810	0.51
Michigan	8,250	134,473	.82
Montana	17,098	186,368	.55
Nevada	13,234	142,879	.54
New Mexico	19,866	278,994	.70
Tennessee [2]	1,762	22,619	.64
Utah	34,952	407,942	.58
Other States	251	6,798	1.35
Total	248,663	2,740,883	.55

[1] Includes following methods of concentration: "Dual process" (leaching followed by concentration); "LPF" (leach-precipitation-flotation); and froth flotation.
[2] Copper-zinc ore.

Table 11.—Copper ore shipped directly to smelters in the United States, by State in 1972, with content in terms of recoverable copper

State	Ore shipped to smelters		
	Short tons	Recoverable copper content	
		Pounds	Percent
Arizona	337,112	13,058,024	1.94
Colorado	59	12,079	10.24
Idaho	1,178	62,432	2.65
Montana	28,329	2,301,685	4.06
Nevada	54,298	739,611	.68
New Mexico	63,117	84,911	[1] .07
Other States	33	1,521	2.30
Total	484,126	16,260,263	1.68

[1] Primarily smelter fluxing material.

Table 12.—Copper precipitates (from dump or in-place leaching) shipped directly to smelters and copper ore leached (heap, vat, or tank) in the United States by State in 1972, 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	82,124	120,759,514	12,227,895	[1] 114,965,689	0.47
Montana	31,316	49,514,860	--	--	--
Nevada	15,053	22,551,731	[2] 4,850,856	[2] 36,731,701	.38
New Mexico	35,305	55,143,738	(2)	(2)	--
Utah	57,214	93,928,415	604,842	13,286,408	1.10
Other States	67	87,292	--	--	--
Total	221,079	341,985,550	17,683,593	164,983,798	.47

[1] Includes 63,280,704 pounds of electrowon copper.
[2] Nevada and New Mexico combined to avoid disclosing individual company confidential data.

Table 13.—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]	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
1968	383	2.46	[2] 169,671	0.60	170,054	0.60	0.0024	0.056	0.21
1969	485	2.17	[3] 204,704	.62	223,752	.60	.0028	.065	.23
1970	542	3.51	[3] 235,586	.60	257,729	.61	.0023	.067	.20
1971	453	1.76	[3] 222,121	.56	242,656	.55	.0022	.059	.18
1972	484	1.68	[3] 248,663	.55	266,831	.55	.0019	.059	.21

[1] Includes some ore classed as copper-zinc and minor amount of tailings (1971 excludes tailings).
[2] Includes all methods of concentration: "Dual process" (leaching followed by flotation concentration), "LPF" (leach-precipitation-flotation), tank or vat leaching, heap leaching, and froth flotation.
[3] Excludes tank or vat and heap leaching. (See tables 8 and 12).

Table 14.—Copper produced by primary smelters in the United States

(Short tons)

Year	Domestic	Foreign	Secondary	Total
1968	1,234,724	31,754	84,821	1,351,299
1969	1,547,496	37,995	77,329	1,662,820
1970	1,605,265	36,073	78,897	1,720,235
1971	1,470,815	29,181	66,333	1,566,329
1972	1,649,130	41,263	69,017	1,759,410

Table 15.—Primary and secondary copper produced by primary refineries in the United States

(Short tons)

	1968	1969	1970	1971	1972
PRIMARY					
From domestic ores, etc.: [1]					
Electrolytic	1,013,246	1,296,749	1,359,751	1,274,084	1,520,943
Lake	78,304	76,417	66,091	57,218	70,025
Casting	69,375	95,723	95,341	79,221	89,444
Total	1,160,925	1,468,889	1,521,183	1,410,523	1,680,412
From foreign ores, etc.: [1]					
Electrolytic	219,726	225,714	215,088	167,213	160,781
Casting and best select	56,735	48,212	28,823	14,046	32,040
Total refinery production of primary copper	1,437,386	1,742,815	1,765,094	1,591,782	1,873,233
SECONDARY					
Electrolytic [2]	327,549	410,749	433,394	323,913	341,581
Casting	15,869	2,094	17,623	18,599	16,667
Total secondary	343,418	412,843	451,017	342,512	358,248
Grand total	1,780,804	2,155,658	2,216,111	1,934,294	2,231,481

[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 16.—Copper cast in forms at primary refineries in the United States

	1971		1972	
	Thousand short tons	Percent	Thousand short tons	Percent
Billets	154	8	118	5
Cakes	116	6	124	6
Cathodes	291	15	552	24
Ingots and ingot bars	175	9	218	10
Wire bars	1,168	60	1,181	53
Other forms	30	2	38	2
Total	1,934	100	2,231	100

Table 17.—Production, shipments, and stocks of copper sulfate

(Short tons)

Year	Production		Shipments	Stocks Dec. 31 [1]
	Quantity	Copper content		
1968	43,784	10,946	43,648	3,380
1969	50,568	12,642	49,556	4,248
1970	45,352	11,338	40,324	8,812
1971	34,648	8,662	36,852	5,936
1972	38,052	9,513	37,964	5,828

[1] Some small quantities are purchased and used by producing companies, so that the figures given do not balance exactly.

Table 18.—Byproduct sulfuric acid [1] (100% basis) produced in the United States

(Short tons)

Year	Copper plants [2]	Lead and zinc plants [3]	Total
1968	483,108	989,973	1,473,081
1969	685,775	1,086,938	1,772,713
1970	747,784	1,090,817	1,838,601
1971	803,284	971,946	1,775,230
1972	1,010,614	859,103	1,869,717

[1] Includes acid from foreign materials.
[2] Includes acid produced at a lead smelter in 1967–68. Excludes acid made from pyrites concentrates in Arizona, Montana, Tennessee, and Utah.
[3] Excludes acid made from native sulfur.

Table 19.—Secondary copper produced in the United States

(Short tons)

	1968	1969	1970	1971	1972
Copper recovered as unalloyed copper	433,041	514,593	521,137	429,095	447,409
Copper recovered in alloys [1]	785,299	860,900	726,465	771,025	853,564
Total secondary copper	1,218,340	1,375,493	1,247,602	1,200,120	1,300,973
Source:					
New scrap	697,568	800,603	743,531	754,963	842,779
Old scrap	520,772	574,890	504,071	445,157	458,194
Percentage equivalent of domestic mine output	101	89	73	79	78

[1] Includes copper in chemicals, as follows: 1968—4,757; 1969—3,824; 1970—2,525; 1971—3,206; and 1972—3,036.

Table 20.—Copper recovered from scrap processed in the United States by kinds of scrap and form of recovery

(Short tons)

Kind of scrap	1971	1972	Form of recovery	1971	1972
New scrap:			As unalloyed copper:		
Copper-base	744,294	829,819	At primary plants	342,512	358,248
Aluminum-base	10,504	12,799	At other plants	86,583	89,161
Nickel-base	165	146			
Zinc-base	--	15	Total	429,095	447,409
Total	754,963	842,779	In brass and bronze	737,814	815,191
			In alloy iron and steel	3,319	2,791
Old scrap:			In aluminum alloys	26,492	32,346
Copper-base	438,846	451,490	In other alloys	194	198
Aluminum-base	5,713	6,200	In chemical compounds	3,206	3,038
Nickel-base	514	400			
Tin-base	8	10	Total	771,025	853,564
Zinc-base	76	94			
			Grand total	1,200,120	1,300,973
Total	445,157	458,194			
Grand total	1,200,120	1,300,973			

Table 21.—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	
	1971	1972	1971	1972	1971	1972
Secondary smelters	58,741	64,135	222,819	229,322	281,560	293,457
Primary copper producers	192,390	211,711	150,122	146,537	342,512	358,248
Brass mills	479,124	535,643	24,848	32,435	503,972	568,078
Foundries and manufacturers	13,574	17,797	38,363	40,639	51,937	58,436
Chemical plants	465	533	2,664	2,557	3,129	3,090
Total	744,294	829,819	438,816	451,490	1,183,110	1,281,309

Table 22.—Production of secondary copper and copper-alloy products in the United States
(Short tons)

Item produced from scrap	1971	1972
UNALLOYED COPPER PRODUCTS		
Refined copper by primary producers	342,512	358,248
Refined copper by secondary smelters	58,150	64,995
Copper powder	28,353	24,073
Copper castings	80	93
Total	429,095	447,409
ALLOYED COPPER PRODUCTS		
Brass and bronze ingots:		
Tin bronzes	23,578	40,994
Leaded red brass and semired brass	165,414	154,607
High-leaded tin bronze	25,088	26,803
Yellow brass	18,085	21,027
Manganese bronze	11,213	10,596
Aluminum bronze	7,370	7,117
Nickel silver	3,561	3,657
Silicon bronze and brass	4,098	4,071
Copper-base hardeners and master alloys	9,804	11,041
Total	268,211	279,913
Brass-mill products	r 632,697	732,502
Brass and bronze castings	34,614	36,244
Brass powder	2,168	560
Copper in chemical products	r 3,206	3,038
Grand total	r 1,369,991	1,499,666

r Revised.

Table 23.—Composition of secondary copper-alloy production
(Short tons)

	Copper	Tin	Lead	Zinc	Nickel	Aluminum	Total
Brass and bronze production: [1]							
1971	207,952	11,501	16,817	31,214	682	45	268,211
1972	210,082	19,106	16,203	33,906	560	56	279,913
Secondary metal content of brass-mill products:							
1971 r	494,770	439	2,917	129,798	4,730	43	632,697
1972	568,081	498	3,609	156,158	4,112	44	732,502
Secondary metal content of brass and bronze castings:							
1971	27,975	1,093	2,760	2,725	8	53	34,614
1972	29,942	1,030	2,450	2,758	7	57	36,244

r Revised.
[1] About 86% from scrap and 14% from other than scrap.

Table 24.—Stocks and consumption of purchased copper scrap in the United States in 1972

(Short tons)

Class of consumer and type of scrap	Stocks Jan. 1	Receipts	Consumption			Stocks Dec. 31
			New scrap	Old scrap	Total	
SECONDARY SMELTERS						
No. 1 wire and heavy copper	2,864	31,560	6,623	25,809	32,432	1,992
No. 2 wire, mixed heavy and light copper	3,173	64,909	12,810	52,077	64,887	3,195
Composition or red brass	3,480	82,967	19,428	63,169	82,597	3,850
Railroad-car boxes	340	2,726	--	2,712	2,712	354
Yellow brass	5,458	65,238	8,003	57,479	65,482	5,214
Cartridge cases and brass	116	157	--	204	204	69
Auto radiators (unsweated)	2,122	64,094	--	63,281	63,281	2,935
Bronze	2,551	27,281	5,483	22,170	27,653	2,179
Nickel silver and cupronickel	519	3,698	534	3,044	3,578	639
Low brass	650	3,739	2,908	805	3,713	676
Aluminum bronze	148	412	328	95	423	137
Low-grade scrap and residues	12,993	78,155	55,194	26,926	82,120	9,028
Total	34,414	424,936	111,311	317,771	429,082	30,268
PRIMARY PRODUCERS						
No. 1 wire and heavy copper	1,165	97,854	56,583	39,360	95,943	3,076
No. 2 wire, mixed heavy and light copper	10,443	192,780	141,104	58,211	199,315	3,908
Refinery brass	690	5,530	3,475	2,652	6,127	28,761 (bracketed with next line)
Low-grade scrap and residues	27,748	233,264	60,523	171,821	232,344	
Total	40,046	529,428	261,685	272,044	533,729	35,745
BRASS MILLS [1]						
No. 1 wire and heavy copper	9,747	172,640	146,198	26,442	172,640	8,168
No. 2 wire, mixed heavy and light copper	3,335	56,882	55,176	1,706	56,882	1,709
Yellow brass	16,007	333,348	333,348	--	333,348	16,973
Cartridge cases and brass	11,018	112,480	105,864	6,616	112,480	7,412
Bronze	734	3,859	3,859	--	3,859	732
Nickel silver and cupronickel	3,645	28,998	28,998	--	28,998	5,589
Low brass	3,678	38,099	38,099	--	38,099	6,538
Aluminum bronze	118	458	458	--	458	123
Total [1]	48,282	746,764	712,000	34,764	746,764	47,244
FOUNDRIES, CHEMICAL PLANTS, AND OTHER MANUFACTURERS						
No. 1 wire and heavy copper	2,358	30,561	10,174	20,281	30,455	2,464
No. 2 wire, mixed heavy and light copper	1,568	11,026	3,566	7,826	11,392	1,202
Composition or red brass	1,037	4,939	2,692	2,219	4,911	1,065
Railroad-car boxes	1,369	5,840	--	6,282	6,282	927
Yellow brass	792	5,454	2,818	2,775	5,593	653
Auto radiators (unsweated)	943	10,304	--	10,259	10,259	988
Bronze	269	567	254	386	640	196
Nickel silver and cupronickel	3	25	19	6	25	3
Low brass	34	663	177	492	669	28
Aluminum bronze	44	515	270	230	500	59
Low-grade scrap and residues	464	703	416	557	973	194
Total	8,881	70,597	[2] 20,386	[2] 51,313	[2] 71,699	7,779
GRAND TOTAL						
No. 1 wire and heavy copper	16,134	332,615	219,578	111,892	331,470	15,700
No. 2 wire, mixed heavy and light copper	18,519	325,597	212,656	119,820	332,476	10,014
Composition or red brass	4,517	87,906	22,120	65,388	87,508	4,915
Railroad-car boxes	1,709	8,566	--	8,994	8,994	1,281
Yellow brass	22,257	404,040	344,169	60,254	404,423	22,840
Cartridge cases and brass	11,134	112,637	105,864	6,820	112,684	7,481
Auto radiators (unsweated)	3,065	74,398	--	73,540	73,540	3,923
Bronze	3,554	31,707	9,596	22,556	32,152	3,107
Nickel silver and cupronickel	4,167	32,721	29,551	3,050	32,601	6,231
Low brass	4,362	42,501	41,184	1,297	42,481	7,242
Aluminum bronze	310	1,385	1,056	325	1,381	319
Low-grade scrap and residues [3]	41,895	317,652	119,608	201,956	321,564	37,983
Total	131,623	1,771,725	1,105,382	675,892	1,781,274	121,036

[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] Of the totals shown, chemical plants reported the following: Unalloyed copper scrap, 561 tons of new and 2,678 old.

[3] Includes refinery brass.

Table 25.—Consumption of copper and brass materials in the United States by principal consuming group

(Short tons)

Year and item	Primary producers	Brass mills	Wire mills	Foundries, chemical plants, and miscellaneous users	Secondary smelters	Total
1971:						
Copper scrap	516,069	654,140	--	65,952	423,488	1,659,649
Refined copper [1]	--	655,782	1,324,894	31,942	6,889	2,019,507
Brass ingot	--	13,154	--	[2] 263,225	--	276,379
Slab zinc	--	136,382	--	[r] 2,262	7,176	[r] 145,820
Miscellaneous	--	--	--	150	6,300	6,450
1972:						
Copper scrap	533,729	746,764	--	71,699	429,082	1,781,274
Refined copper [1]	--	667,218	1,526,296	35,400	9,953	2,238,867
Brass ingot	--	16,691	--	[2] 284,581	--	301,272
Slab zinc	--	179,781	--	2,613	9,435	191,829
Miscellaneous	--	--	--	200	10,016	10,216

[r] Revised.
[1] Detailed information on consumption of refined copper will be found in table 29.
[2] Shipments to foundries by smelters plus decrease in stocks at foundries.

Table 26.—Foundry consumption of brass ingot, by type, in the United States

(Short tons)

	1968	1969	1970	1971	1972
Tin bronzes	41,758	43,772	47,474	44,279	52,365
Leaded red brass and semired brass	149,139	155,895	128,798	132,474	148,182
High-leaded tin bronze	20,021	20,278	79,960	107,700	114,332
Yellow brass	29,039	32,998			
Manganese bronze	10,274	10,680	14,545	8,555	10,229
Hardeners and master alloys	3,822	4,315	5,196	5,545	7,257
Nickel silver	3,870	4,041	3,265	3,466	2,838
Aluminum bronze	10,202	8,498	7,903	7,478	6,947
Total	268,125	280,477	287,141	309,497	342,150

Table 27.—Foundry consumption of brass ingot by types, refined copper, and copper scrap, in the United States in 1972, by geographic division and State

(Short tons)

Geographic division and State	Tin bronzes	Leaded red brass and semi-red brass	High leaded tin bronze	Yellow brass	Manganese bronze	Hardeners and master alloys	Nickel silver	Aluminum bronze	Total brass ingot	Refined copper consumed	Copper scrap consumed
New England:											
Connecticut	712	3,463	91	1,989	96			216	6,574	33	803
Massachusetts	1,816	3,690	246	389	326	35	390	39	6,716	364	143
Maine, New Hampshire, Rhode Island, and Vermont	188	2,334	74	189	409			13	3,415	5	3
Total	2,716	9,487	411	2,567	831	35	390	268	16,705	402	949
Middle Atlantic:											
New Jersey	667	1,955	62	242	214	8	57	46	3,251	2,851	2,669
New York	5,007	5,636	704	579	818	138	65	192	13,139	1,172	2,724
Pennsylvania	7,976	13,379	976	1,550	815	1,274	553	792	27,315	7,065	8,080
Total	13,650	20,970	1,742	2,371	1,847	1,420	675	1,030	43,705	11,088	13,473
East North Central:											
Illinois	2,924	16,561	529	619	961	193	24	883	22,694	1,739	2,546
Indiana	1,098	21,330	364	490	280	1,813	272	87	25,734	1,231	8,053
Michigan	20,199	10,913	[1] 8,185	W	2,118	2,350	119	1,406	142,071	7,243	1,119
Ohio		14,458			954		11	481		4,504	9,926
Wisconsin	940	7,534	1,528	784	75	1,033	407	188	12,489	3,576	612
Total	25,161	70,796	[1] 93,376	[2] W	4,388	5,389	833	3,045	202,988	18,293	22,256
West North Central:											
Iowa, Kansas, and Minnesota	419	6,070	64	236	1,032	89	7	118	8,031	353	716
Missouri, Nebraska, and South Dakota	91	1,322	697	1,223	296			684	4,317	915	1,915
Total	510	7,392	761	1,459	1,328	89	7	802	12,348	1,268	2,631
South Atlantic:											
Delaware, District of Columbia, Florida, Georgia, and Maryland	734	1,119	--	141	127	3	526	106	2,755	232	696
North Carolina, South Carolina, Virginia, and West Virginia	3,522	4,525	318	372	157		--	340	9,235	247	3,842
Total	4,256	5,644	318	513	284	3	526	446	11,990	479	4,538
East South Central: Alabama, Kentucky, Mississippi, and Tennessee	2,689	11,585	653	5,351	484	53	165	50	21,030	1,661	11,229
West South Central: Arkansas, Louisiana, Oklahoma, and Texas	1,552	5,463	375	2,297	294	16	171	943	11,111	1,035	1,612
Mountain: Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, and Utah	190	303	14	30	141	1	--	15	694	144	450
Pacific:											
California	1,316	16,441	121	1,931	529	115	67	197	20,717	125	10,238
Oregon and Washington	325	101	40	2	103	136	4	151	862	51	1,084
Total	1,641	16,542	161	1,933	632	251	71	348	21,579	176	11,322
Grand total	52,365	148,182	[1] 114,332	[2] W	10,229	7,257	2,838	6,947	342,150	34,546	68,460

W Withheld to avoid disclosing individual company confidential data.
[1] Total includes yellow brass.
[2] Total includes high-leaded tin bronze.

Table 28.—Primary refined copper supply and withdrawals on domestic account

(Short tons)

	1968	1969	1970	1971	1972
Production from domestic and foreign ores, etc.	1,437,386	1,742,815	1,765,094	1,591,782	1,873,233
Imports [1]	400,278	131,171	132,143	163,988	192,379
Stocks Jan. 1 [1]	27,000	48,000	39,000	130,000	75,000
Total available supply	1,864,664	1,921,986	1,936,237	1,885,770	2,140,612
Copper exports [1]	240,745	200,269	221,211	187,654	182,743
Stocks Dec. 31 [1]	48,000	39,000	130,000	75,000	57,000
Total	288,745	239,269	351,211	262,654	239,743
Apparent withdrawals on domestic account [2]	1,576,000	1,683,000	1,585,000	1,623,000	1,901,000

[1] May include some copper refined from scrap.
[2] Includes copper delivered by industry to the Government stockpiles.

Table 29.—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
1971:							
Wire mills	108,498	1,206,895	W	W	W	9,501	1,324,894
Brass mills	192,617	28,042	99,087	154,667	181,259	110	655,782
Chemical plants	--	--	191	--	--	1,320	1,511
Secondary smelters	4,221	--	2,666	--	--	2	6,889
Foundries	2,183	1,659	8,950	W	W	852	13,644
Miscellaneous [1]	1,907	332	7,447	170	1,000	5,931	16,787
Total	309,426	1,236,928	118,341	154,837	182,259	17,716	2,019,507
1972:							
Wire mills	222,894	1,295,401	W	W	W	8,001	1,526,296
Brass mills	192,263	34,402	119,710	160,201	160,642	--	667,218
Chemical plants	--	--	35	--	--	819	854
Secondary smelters	5,602	W	4,129	--	W	222	9,953
Foundries	2,790	1,494	9,705	W	W	1,236	15,225
Miscellaneous [1]	1,789	632	7,860	312	797	7,931	19,321
Total	425,338	1,331,929	141,439	160,513	161,439	18,209	2,238,867

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 30.—Stocks of copper at primary smelting and refining plants in the United States, Dec. 31

(Thousand short tons)

Year	Refined copper [1]	Blister and materials in process of refining [2]
1968	48	272
1969	39	291
1970	130	340
1971	75	303
1972	57	281

[1] May include some copper refined from scrap.
[2] Includes copper in transit from smelters in the United States to refineries therein.

Table 31.—Stocks of copper in fabricators' hands Dec. 31
(Short tons)

Year	Stocks of refined copper [1] (1)	Unfilled purchases of refined copper from producers (2)	Working stocks (3)	Unfilled sales to customers (4)	Excess stocks over orders booked [2] (5)
1968	514,553	128,919	420,186	273,469	−50,183
1969	502,300	99,232	412,734	256,299	−67,501
1970	515,096	86,925	438,925	156,007	7,089
1971	510,810	96,209	431,348	187,688	−12,017
1972	460,062	91,845	392,920	178,121	−19,134

[1] Includes in-process metal and primary fabricated shapes. Also includes small quantities of refined copper held at refineries for fabricators' account.
[2] Columns (1) plus (2) minus (3) and minus (4) equal column (5).

Source: United States Copper Association.

Table 32.—Dealers' monthly average buying price for copper scrap and consumers' alloy-ingot prices at New York in 1972
(Cents per pound)

Grade	Jan.	Feb.	Mar.	Apr.	May	June	
No. 2 copper scrap	30.71	32.35	35.17	35.00	34.09	31.50	
No. 1 composition scrap	30.67	30.15	32.54	32.80	32.14	29.91	
No. 1 composition ingot	49.50	50.59	54.77	55.75	53.31	51.43	
	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
No. 2 copper scrap	30.00	30.17	29.85	29.55	29.00	29.20	31.38
No. 1 composition scrap	28.00	28.17	28.30	27.80	27.00	27.00	29.54
No. 1 composition ingot	51.25	51.25	51.25	51.25	51.25	51.25	51.90

Source: Metal Statistics, 1973.

Table 33.—Average weighted prices of copper delivered [1]
(Cents per pound)

Year	Domestic copper	Foreign copper
1968	42.2	51.4
1969	47.9	63.2
1970	58.2	64.1
1971	52.0	49.3
1972	51.2	48.6

Source: Metals Week.

Table 34.—Average monthly quoted prices of electrolytic copper for domestic delivered, in the United States and for spot copper at London
(Cents per pound)

Month	1971			1972		
	Domestic delivered		London spot [1]	Domestic delivered		London spot [1]
	American Metal Market	Metals Week	Metals Week	American Metal Market	Metals Week	Metals Week
January	51.48	51.52	45.18	50.38	50.32	48.84
February	50.38	50.35	45.86	50.66	50.60	50.42
March	50.48	50.55	51.45	52.62	52.57	52.51
April	52.88	52.83	56.26	52.62	52.57	51.33
May	52.88	52.84	50.11	52.62	52.57	50.16
June	52.88	52.84	48.29	52.62	52.57	48.06
July	52.88	(2)	50.14	50.67	50.63	46.91
August	52.88	52.90	49.02	50.62	50.61	47.46
September	52.88	52.89	47.13	50.62	50.61	48.09
October	52.88	52.84	46.44	50.62	50.61	46.57
November	52.19	52.24	45.24	50.62	50.61	45.62
December	50.38	50.32	46.32	50.62	50.61	46.34
Average	52.09	52.01	48.49	51.44	51.24	48.53

[1] Based on average monthly rates of exchange by Federal Reserve Board.
[2] Suspended.

Table 35.—U.S. exports of copper by class and country

Year and country	Ore, concentrates, and matte (copper content)		Ash and residues (copper content)		Refined	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1971	8,126	$8,430	--	--	187,654	$187,948
1972:						
Africa	--	--	--	--	1	(1)
Argentina	--	--	--	--	144	153
Belgium-Luxembourg	362	280	2,725	$1,925	3,337	3,022
Brazil	--	--	--	--	16,079	16,026
Canada	3,382	3,251	490	115	18,334	18,340
Denmark	--	--	--	--	1,241	1,178
France	--	--	--	--	25,426	25,557
Germany, West	1,899	1,835	1,643	866	28,505	27,826
Guatemala	--	--	--	--	66	71
India	--	--	--	--	256	268
Italy	31	17	26	6	28,510	28,270
Japan	11,937	8,784	240	195	32,659	33,504
Korea, Republic of	--	--	--	--	932	954
Mexico	--	--	--	--	22	28
Netherlands	--	--	--	--	3,386	3,490
Oceania	--	--	--	--	55	70
Pakistan	--	--	--	--	140	150
Philippines	--	--	--	--	1,555	1,569
Spain	--	--	3,839	2,283	60	58
Sweden	--	--	18	19	2,466	2,439
Switzerland	--	--	--	--	1,644	1,651
Taiwan	--	--	330	156	4,717	4,843
Thailand	--	--	--	--	500	509
United Kingdom	--	--	70	136	12,052	11,697
Venezuela	--	--	--	--	600	678
Other	1	(1)	--	--	56	79
Total	17,612	14,167	9,381	5,701	182,743	182,430

Year and country	Scrap		Blister		Pipes and tubing	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1971	18,435	$15,621	28,698	$22,242	1,249	$2,541
1972:						
Africa	--	--	--	--	41	124
Argentina	--	--	--	--	(1)	1
Belgium-Luxembourg	940	775	7,845	6,015	3	8
Brazil	--	--	--	--	25	141
Canada	4,177	2,955	11	10	579	1,144
Denmark	--	--	--	--	--	--
France	--	--	1	1	11	18
Germany, West	495	430	604	559	2	8
Guatemala	--	--	--	--	--	--
India	20	20	--	--	22	52
Italy	950	692	--	--	81	162
Japan	4,804	4,007	(1)	1	2	4
Korea, Republic of	1,726	1,505	--	--	1	4
Mexico	2,040	1,257	4	3	43	99
Netherlands	--	--	102	90	6	14
Oceania	--	--	--	--	12	23
Pakistan	--	--	--	--	44	83
Philippines	55	55	--	--	11	22
Spain	1,579	1,099	--	--	1	2
Sweden	--	--	--	--	1	1
Switzerland	--	--	--	--	--	--
Taiwan	139	134	--	--	(1)	1
Thailand	--	--	--	--	2	10
United Kingdom	129	141	--	--	2	4
Venezuela	1	(1)	--	--	9	31
Other	385	327	2	1	244	505
Total	17,440	13,397	8,569	6,680	1,142	2,461

See footnotes at end of table.

Table 35.—U.S. exports of copper by class and country—Continued

Year and country	Plates and sheets		Wire and cable, bare		Wire and cable, insulated		Other copper manufactures [2]	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1971	287	$550	1,925	$3,207	24,590	$73,057	7,746	$9,145
1972:								
Africa	(1)	1	49	79	1,195	2,870	5	8
Argentina	--	--	2	5	112	406	1	2
Belgium-Luxembourg	--	--	38	69	228	1,031	81	83
Brazil	--	--	29	45	556	1,702	166	189
Canada	190	396	496	774	10,568	39,170	443	657
Denmark	--	--	(1)	1	56	243	(1)	1
France	27	49	29	51	548	814	30	48
Germany, West	--	--	20	25	681	2,233	6	11
Guatemala	--	--	1	2	26	69	--	--
India	5	11	730	826	19	124	(1)	1
Italy	1	4	12	40	147	829	38	40
Japan	1	1	33	60	229	912	3	4
Korea, Republic of	--	--	1	4	41	115	--	--
Mexico	20	54	244	326	4,791	14,122	6	10
Netherlands	--	--	19	58	641	1,750	35	72
Oceania	1	1	16	51	202	631	1	1
Pakistan	9	19	--	--	7	43	1,374	1,563
Philippines	3	8	52	79	466	734	25	26
Spain	(1)	1	32	50	60	178	--	--
Sweden	--	--	30	44	81	408	--	--
Switzerland	--	--	(1)	6	61	244	128	174
Taiwan	--	--	11	22	106	468	9	14
Thailand	3	8	(1)	1	29	110	--	--
United Kingdom	4	8	35	57	511	2,476	25	115
Venezuela	10	21	3	10	577	1,120	2,385	2,671
Other	5	15	885	1,576	6,722	15,508	1,538	1,710
Total	279	597	2,767	4,261	28,660	88,310	6,299	7,400

[1] Does not include wire cloth: 1971, 1,472,504 square feet ($495,858); 1972, 908,651 square feet ($450,713).
[2] Less than ½ unit.

Table 36.—U.S. exports of copper, by class

Year	Ore, concentrate, and matte (copper content)		Blister		Refined copper and semimanufactures	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1970	61,538	$58,366	7,805	$7,503	249,217	$370,388
1971	8,126	8,430	28,698	22,242	215,705	267,303
1972	17,612	14,167	8,569	6,680	215,591	278,059

Year	Other copper manufactures [1]		Total	
	Short tons	Value (thousands)	Short tons	Value (thousands)
1970	6,057	$8,568	324,617	$444,825
1971	7,746	9,145	260,275	307,120
1972	6,299	7,400	248,071	306,306

[1] Does not include wire cloth; 1970, 1,151,648 square feet ($476,767); 1971, 1,472,504 square feet ($495,858); 1972, 908,651 square feet ($450,713).

Table 37.—U.S. exports of copper-base alloy (including brass and bronze), by class

Class	1971 Short tons	1971 Value (thousands)	1972 Short tons	1972 Value (thousands)
Ingots	181	$467	289	$1,074
Scrap and waste	r 76,872	r 58,110	67,525	51,155
Bars, rods, and shapes	6,434	8,453	7,154	9,211
Plates, sheets, and strips	2,112	7,362	3,848	11,617
Pipes and tubing	2,563	5,064	2,035	4,060
Pipe fittings	3,651	10,246	4,073	12,297
Plumbers' brass goods	1,072	3,034	1,278	4,258
Welding rods and wire	1,737	4,092	1,254	3,238
Castings and forgings	945	1,607	909	1,491
Powder and flakes	1,942	3,125	1,850	2,967
Foil	466	1,436	162	488
Articles of copper and copper-base alloys, n.e.c.	(1)	3,844	(1)	3,730
Total	r 97,975	r 106,840	90,377	105,586

r Revised.
[1] Quantity not reported.

Table 38.—U.S. exports of unfabricated copper-base alloy[1] ingots, bars, rods, shapes, plates, sheets, and strip

Year	Short tons	Value (thousands)
1970	5,515	$14,209
1971	8,727	16,282
1972	11,291	21,902

[1] Includes brass and bronze.

Table 39.—U.S. exports of copper sulfate

(Blue vitriol)

Year	Short tons	Value (thousands)
1970	2,485	$1,543
1971	2,815	2,078
1972	2,646	1,767

Table 40.—U.S. exports of copper scrap, by country

Country	Unalloyed copper scrap				Copper alloy scrap			
	1971		1972		1971		1972	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
Austria	--	--	--	--	316	$210	--	--
Belgium-Luxembourg	2,493	$2,118	940	$775	5,254	4,060	1,089	$755
Canada	3,906	3,025	4,177	2,955	6,592	5,520	5,953	5,160
France	65	53	--	--	372	269	47	38
Germany:								
East	--	--	161	144	127	103	66	42
West	3,869	3,519	495	430	10,127	8,459	2,993	2,382
Hong Kong	81	69	--	--	342	277	59	50
India	267	252	20	20	362	339	229	224
Israel	33	33	--	--	150	125	--	--
Italy	760	615	950	692	7,036	5,006	8,254	5,433
Japan	2,099	1,789	4,804	4,007	30,919	22,642	40,928	31,008
Korea, Republic of	1,293	1,163	1,726	1,505	3,271	2,793	3,583	3,163
Mexico	410	266	2,040	1,257	2,824	2,250	138	113
Netherlands	43	22	--	--	212	194	371	304
Spain	2,505	2,184	1,579	1,099	3,210	2,242	1,894	1,109
Sweden	77	67	--	--	3,548	1,849	1,078	715
Taiwan	70	54	139	134	1,147	965	132	112
United Kingdom	217	182	129	141	523	349	558	397
Yugoslavia	43	43	--	--	121	112	--	--
Other	204	167	280	238	419	346	153	150
Total	18,435	15,621	17,440	13,397	76,872	58,110	67,525	51,155

Table 41.—U.S. imports for consumption of copper scrap, by country

Country	Unalloyed copper scrap (copper content)			
	1971		1972	
	Short tons	Value (thousands)	Short tons	Value (thousands)
Bahamas	84	$68	39	$29
Bermuda	17	15	19	17
Canada	5,063	4,741	7,831	7,393
Chile	(1)	(1)	254	220
Dominican Republic	231	188	73	54
France	1	2	105	146
Germany, West	39	29	56	42
Guatemala	22	15	93	91
Honduras	45	57	42	55
Jamaica	99	77	76	51
Japan	--	--	322	68
Mexico	1,719	1,319	1,445	1,143
Nicaragua	--	--	72	59
Panama	52	42	189	157
United Kingdom	77	121	155	219
Other	r 10	5	16	22
Total	7,459	6,679	10,787	9,766

Country	Copper alloy scrap					
	1971			1972		
	Gross weight short tons	Copper content short tons	Value (thousands)	Gross weight short tons	Copper content short tons	Value (thousands)
Bahamas	105	75	$67	73	46	$46
Canada	8,186	5,562	5,584	10,020	6,524	6,820
Dominican Republic	197	156	135	609	510	396
France	--	--	--	13	11	11
Germany, West	--	--	--	21	14	9
Gibraltar	--	--	--	10	7	7
Guatemala	18	12	10	85	69	66
Haiti	--	--	--	28	22	19
Israel	--	--	--	34	30	27
Jamaica	174	113	90	29	28	21
Japan	--	--	--	17	12	10
Mexico	238	169	140	257	142	129
Nicaragua	--	--	--	25	18	15
Panama	240	190	167	213	163	141
Spain	--	--	--	20	16	14
Trinidad and Tobago	--	--	--	111	88	64
United Kingdom	55	47	57	318	267	269
Other	14	8	8	3	1	1
Total	9,227	6,332	6,258	11,886	7,968	8,065

r Revised.
1 Less than ½ unit.

Table 42.—U.S. imports [1] of copper (unmanufactured), by class and country

(Short tons, copper content, and thousand dollars)

Year and country	Ore, concentrates		Matte		Blister	
	Quantity	Value	Quantity	Value	Quantity	Value
1970	32,741	40,394	1,100	1,389	224,416	245,903
1971:						
Australia	1,243	809	--	--	--	--
Canada	6,986	5,088	339	253	12	18
Chile	--	--	--	--	40,594	38,668
Germany, West	--	--	2	2	28	41
Japan	--	--	--	--	36	32
Mexico	4	2	--	--	4,926	5,012
Netherlands	--	--	98	204	--	--
Peru	8,999	8,562	--	--	89,901	81,890
Philippines	13,616	13,041	--	--	--	--
South Africa, Republic of	--	--	--	--	21,247	21,467
Other	--	--	1	1	--	--
Total	30,848	27,502	440	460	156,744	147,128

Table 42.—U.S. imports [1] of copper (unmanufactured), by class and country—Continued

(Short tons, copper content, and thousand dollars)

Year and country	Ore, concentrates		Matte		Blister	
	Quantity	Value	Quantity	Value	Quantity	Value
1972:						
Australia	2,091	1,607	--	--	44	45
Canada	11,603	8,628	515	355	5,871	5,598
Chile	--	--	71	36	33,208	31,197
Colombia	55	4	--	--	--	--
Finland	--	--	11	11	--	--
Germany, West	--	--	--	--	1	(1)
India	--	--	--	--	110	108
Israel	--	--	--	--	14	12
Japan	--	--	--	--	18	26
Kenya	--	--	--	--	1,804	1,653
Mexico	8	2	--	--	9,544	9,868
Nicaragua	95	64	--	--	--	--
Panama	195	125	--	--	--	--
Peru	9,486	8,929	--	--	81,559	71,806
Philippines	30,122	29,677	--	--	--	--
South Africa, Republic of	--	--	--	--	23,053	22,360
United Kingdom	--	--	761	685	1	3
Yugoslavia	--	--	--	--	2,205	2,088
Total	53,655	49,036	1,358	1,087	157,432	144,764

Year and country	Refined		Scrap		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1970	132,143	146,093	2,080	1,841	392,480	435,620
1971:						
Australia	338	338	--	--	1,581	1,147
Belgium-Luxembourg	551	599	--	--	551	599
Canada	123,028	122,753	5,063	4,741	135,428	132,853
Chile	11,057	11,003	(2)	(2)	51,651	49,671
France	443	414	1	2	444	416
Germany, West	4,387	4,953	39	29	4,456	5,025
Japan	--	--	--	--	36	32
Mexico	991	997	1,719	1,319	7,640	7,330
Netherlands	1,603	1,815	--	--	1,701	2,019
Norway	116	121	--	--	116	121
Peru	3,510	3,913	--	--	102,410	94,365
Philippines	--	--	--	--	13,616	13,041
Poland	434	r 460	--	--	434	r 460
South Africa, Republic of	--	--	--	--	21,247	21,467
Sweden	1,764	1,764	--	--	1,764	1,764
United Kingdom	5,513	5,990	77	121	5,590	6,111
Yugoslavia	3,585	r 3,546	--	--	3,585	r 3,546
Zambia	6,668	6,634	--	--	6,668	6,634
Other	--	--	560	467	561	468
Total	163,988	r 165,300	7,459	6,679	359,479	r 347,069
1972:						
Australia	388	394	--	--	2,523	2,046
Brazil	370	377	--	--	370	377
Canada	124,983	123,494	7,831	7,393	150,803	145,468
Chile	26,598	25,520	254	220	60,131	56,973
Colombia	--	--	--	--	55	4
Finland	--	--	--	--	11	11
France	8	8	105	146	113	154
Germany, West	1	3	56	42	58	45
Honduras	--	--	42	55	42	55
India	--	--	--	--	110	108
Israel	--	--	--	--	14	12
Japan	1,125	1,045	322	68	1,465	1,139
Kenya	--	--	--	--	1,804	1,653
Mexico	7,620	7,568	1,445	1,143	18,617	18,581
Nicaragua	--	--	72	59	167	123
Norway	208	201	--	--	208	201
Panama	--	--	189	157	384	282
Peru	2,204	2,047	--	--	93,249	82,782
Philippines	--	--	--	--	30,122	29,677
South Africa, Republic of	556	519	--	--	23,609	22,879
United Kingdom	3,938	4,172	155	219	4,855	5,079
Yugoslavia	24,379	23,534	--	--	26,584	25,622
Other	1	1	316	264	317	265
Total	192,379	188,883	10,787	9,766	415,611	393,536

r Revised.

[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 43.—U.S. imports for consumption of copper (copper content) by class

(Short tons and thousand dollars)

Year	Ore and concentrates		Matte		Blister	
	Quantity	Value	Quantity	Value	Quantity	Value
1970	64,540	77,367	247	346	224,289	245,778
1971	5,547	4,091	119	220	153,625	144,395
1972	80,740	81,055	1,453	1,134	77,162	72,514

Year	Refined		Scrap		Total value
	Quantity	Value	Quantity	Value	
1970	132,143	149,169	2,308	2,044	474,704
1971	163,988	[r]165,300	7,459	6,679	[r]320,685
1972	175,703	172,772	10,787	9,766	337,241

[r] Revised.

Table 44.—Copper: World mine production, by country [1]

(Short tons)

Country	1970	1971	1972 [p]
North and Central America:			
Canada [2]	672,717	721,429	800,619
Cuba [e]	3,300	3,300	3,300
Dominican Republic	468	[e]500	[e]500
Haiti [3]	5,344	7,300	[e]7,400
Mexico	67,254	69,611	86,774
Nicaragua [3]	3,705	4,037	3,970
United States [2]	1,719,657	1,522,183	1,664,840
South America:			
Argentina	508	500	[e]500
Bolivia [4]	9,655	8,281	9,324
Brazil [5]	4,233	5,622	4,745
Chile	783,391	790,722	798,919
Colombia	55	62	71
Ecuador	562	622	[e]660
Peru	242,756	234,665	248,031
Europe:			
Albania [6]	6,160	[e]7,000	[e]7,200
Austria	2,493	2,920	2,539
Bulgaria	47,500	50,000	53,000
Czechoslovakia	[r]4,850	4,960	5,300
Finland	[r]34,150	31,317	38,387
France	276	330	550
Germany, East [e] [6]	11,000	2,200	2,650
Germany, West	1,404	1,524	1,456
Hungary [e]	1,100	1,300	1,300
Ireland	9,128	12,992	14,200
Italy	[r]2,329	[7]1,698	[7]1,193
Norway [7]	[r]21,772	23,889	27,971
Poland [e]	79,400	99,200	135,000
Portugal [7]	4,103	4,362	5,290
Romania [e] [2]	14,300	15,700	38,600
Spain [7] [8]	10,496	37,514	35,461
Sweden	28,972	33,313	27,300
U.S.S.R. [e] [6]	630,000	680,000	733,000
Yugoslavia	100,099	104,049	113,684
Africa:			
Algeria	633	[e]660	[e]660
Angola	40	--	--
Congo (Brazzaville) [3]	60	456	[e]550
Kenya	87	80	79
Morocco [3]	3,167	3,472	4,233
Mozambique [3]	166	456	778
Rhodesia, Southern [9]	29,241	32,338	42,218
South Africa, Republic of	164,470	173,581	178,494
South-West Africa, Territory of [3] [10]	34,605	35,317	[e]35,825
Uganda	[r]21,117	18,810	17,296
Zaire	425,138	447,349	472,891
Zambia	754,100	718,300	790,500
Asia:			
Burma [11]	77	88	88
China, People's Republic of [e]	110,000	110,000	110,000
Cyprus [7]	20,019	21,376	[12]20,900
India	11,312	11,867	12,856
Iran [13]	[r]315	1,106	[e]2,200

See footnotes at end of table.

Table 44.—Copper: World mine production, by country [1]—Continued

(Short tons)

Country	1970	1971	1972 p
Asia—Continued			
Israel	9,084	11,161	12,318
Japan [3]	131,740	133,411	125,248
Korea, North e	14,000	14,000	14,000
Korea, Republic of	1,807	1,955	2,295
Malaysia	336	235	276
Philippines	176,696	217,787	225,970
Taiwan e	2,700	2,600	2,200
Turkey	30,010	21,429	27,217
Oceania:			
Australia	173,933	192,018	203,930
Fiji	--	--	3
New Zealand	52	94	136
Papua New Guinea	--	--	136,641
Total	r 6,638,042	6,653,048	7,313,536

e Estimate. p Preliminary. r Revised.

[1] Data presented 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] Partly estimated, partly calculated on the basis of data furnished by Companhia Brasiliera de Cobre.

[6] Smelter production.

[7] Includes copper content of cupriferous pyrites.

[8] Excludes an unreported quantity of copper in iron pyrites which may or may not be recovered.

[9] Year ending September 30 of that stated.

[10] Output of Tsumeb Corporation Ltd. and Klein Aub Koper Maatskappy Beperk for years ending June 30 of that stated.

[11] Content of matte produced.

[12] Exports.

[13] Year beginning March 21 of that stated.

Table 45.—Copper: World smelter production, by country [1]

(Short tons)

Country	1970	1971	1972 [p]
North America:			
Canada	538,699	526,400	[e] 535,723
Mexico [2]	65,708	68,273	81,831
United States [3]	1,641,338	1,499,996	1,690,391
South America:			
Argentina [e]	330	330	330
Brazil [4]	4,189	4,299	5,291
Chile [5]	725,547	704,462	736,971
Peru	195,020	183,779	191,541
Europe:			
Albania	6,160	7,700	7,940
Austria [6]	21,204	24,160	25,015
Belgium [e] [7]	11,000	11,000	7,700
Bulgaria	48,200	50,000	53,000
Czechoslovakia [8]	4,400	5,000	5,300
Finland	37,530	35,648	42,355
Germany, East	11,000	2,200	2,650
Germany, West	93,000	96,300	110,124
Hungary [8]	1,100	1,300	1,300
Norway [9]	35,591	37,988	37,372
Poland [6]	79,600	102,200	144,400
Portugal	4,416	4,630	4,189
Romania [e]	11,000	12,000	38,600
Spain	[r] 60,705	73,047	98,009
Sweden [6] [10]	40,412	45,000	43,000
U.S.S.R. [e]	630,000	680,000	733,000
Yugoslavia	116,736	122,692	144,700
Africa:			
Rhodesia, Southern [11]	[r] 26,895	30,764	45,277
South Africa, Republic of	159,500	167,900	185,000
South-West Africa, Territory of [12]	31,519	29,676	28,791
Uganda	18,693	17,340	15,618
Zaire	424,988	444,701	447,317
Zambia	753,153	698,221	769,000
Asia:			
China, People's Republic of	110,000	110,000	110,000
India	10,264	10,668	10,732
Japan [13]	668,066	728,871	740,750
Korea, North [e]	14,000	14,000	14,000
Korea, Republic of [14]	5,641	7,550	9,988
Taiwan	4,136	4,045	5,156
Turkey	18,716	19,359	18,613
Oceania: Australia	123,075	157,905	159,455
Total	6,751,531	6,739,404	7,300,429

[e] Estimate. [p] Preliminary. [r] Revised.

[1] Unless otherwise noted, data presented for each country represent the nonduplicative sum of production of primary blister copper, primary refined copper of nonblister origin, and any primary refined copper derived from unreported quantities of domestically smelted blister copper.

[2] Copper content of impure bars and electrolytic copper.

[3] Smelter output from domestic and foreign ores, exclusive of that produced from scrap. Production from domestic ores only was as follows: 1970—1,605,265; 1971—1,470,815; and 1972—1,649,130.

[4] Includes secondary copper (production from scrap). Partly estimated, partly calculated on the basis of data furnished by Companhia Brasileira de Cobre.

[5] Data are the nonduplicatve sum of: (1) the copper content of blister copper production for sale as such; (2) the copper content of blister copper produced for refining in Chile at the Ventanas refinery; and (3) the copper content of fire refined and electrolytic copper (including copper obtained by electrowinning) excluding electrolytic output of the Ventanas refinery.

[6] Refined.

[7] Belgium reports a large output of refined copper, but this is produced largely from imported blister; estimate of domestic smelter production is based chiefly on reported imports of ores and concentrates.

[8] Series revised; data presented are output of primary smelter. Data presented in previous editions of this chapter represented output of refined metal including secondary (production from scrap).

[9] Reported Norwegian copper output is derived in part form 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 tons: 1970—6,500; 1971—6,700; and 1972—7,500.

[10] Series revised to exclude secondary copper; data presented in previous editions of this chapter included secondary refined copper.

[11] Year ending September 30 of that stated.

[12] Year ending June 30 of that stated.

[13] Series revised; data presented are output of blister copper (including a relatively small quantity of secondary blister, derived from scrap). Data presented in previous editions of this chapter represented output of refined copper, including a substantial quantity produced from scrap as well as quantities produced from imported blister copper.

[14] Refined including secondary.

Table 46.—Chile: Exports of copper, by type

(Short tons of contained copper)

Destination	1971 Refined Electrolytic	1971 Refined Fire refined	1971 Blister	1971 Unsmelted[1]	1971 Total	1972 Refined[2]	1972 Blister	1972 Unsmelted[1]	1972 Total
Argentina	28,200	4,400	(3)	--	32,600	31,100	--	--	31,100
Austria	900	--	[r]600	--	1,500	1,000	--	--	1,000
Belgium	3,300	1,300	[r]7,000	4,400	16,000	5,200	3,900	1,800	10,900
Brazil	9,700	1,900	--	--	11,600	8,400	--	--	8,400
Canada	1,400	--	--	1,200	2,600	--	--	--	--
China, People's Repubic of	[r]9,200	--	8,800	--	18,000	15,600	33,000	--	48,600
Colombia	--	300	--	--	300	300	--	--	300
Czechoslovakia	1,100	--	--	--	1,100	300	--	--	300
Denmark	2,000	--	--	--	2,000	1,700	--	--	1,700
Finland	1,800	--	100	--	1,900	1,300	--	--	1,300
France	34,300	17,400	--	--	51,700	35,100	--	--	35,100
Germany, East	--	--	--	--	--	--	--	400	400
Germany, West	114,800	13,100	41,700	14,200	183,800	103,900	34,100	17,200	155,200
Greece	700	--	--	--	700	[4]100	[4]6,300	--	[4]6,400
Italy	56,300	13,800	2,300	--	72,400	61,200	800	--	62,000
Japan	32,300	--	[r]35,100	56,900	124,300	32,100	16,500	40,900	89,500
Korea, Republic of (South)	[r]600	--	--	--	600	--	--	--	--
Mexico	--	--	--	4,300	4,300	--	--	--	--
Netherlands	6,500	--	1,100	--	7,600	7,400	(3)	--	7,400
Norway	2,100	--	--	--	2,100	1,400	--	--	1,400
Poland	--	--	600	--	600	--	--	--	--
Romania	--	--	--	--	--	[4]1,900	--	--	[4]1,900
Spain	[r]5,900	[r]600	3,600	5,000	15,100	5,000	--	8,900	13,900
Sweden	16,200	[r]5,900	[r]1,700	400	24,200	19,400	3,600	800	23,800
Switzerland	[r]1,900	800	--	600	3,300	1,500	--	--	1,500
U.S.S.R.	--	--	--	--	--	[4]8,800	--	--	[4]8,800
United Kingdom	55,800	12,500	43,500	--	111,800	55,700	34,500	--	90,200
United States	18,300	--	38,800	--	57,100	43,900	27,400	200	71,500
Yugoslavia	3,600	--	2,800	--	6,400	--	--	--	--
Other	400	--	--	--	400	3,700	5,500	3,200	12,400
Total	407,300	72,000	187,700	87,000	754,000	446,000	165,600	73,400	685,000

[r] Revised.
[1] Includes copper content of ores, concentrates and cement.
[2] Data for the entire year 1972 are not distributed between electrolytic and fire-refined: During the first nine months, fire refined totaled 69,000 short tons and electrolytic refined totaled 252,600 short tons.
[3] Less than ½ unit.
[4] Data for first 9 months only; shipments (if any) to this destination during the last 3 months are included with "Other."

Sources: 1971 data: Corporación del Cobre Chile. Indicatores del Cobre y Subproductos, Boletin Estadistico Anual 1971. Santiago, June 1972, 20 pp. 1972 data: World Bureau of Metal Statistics. World Metal Statistics, September 1973, London p. 45.

Table 47.—Peru: Copper production

(Short tons)

	Blister	Refined	Other	Total
1970	155,140	39,879	47,737	242,756
1971	147,887	35,892	50,886	234,665
1972 [p]	148,316	43,225	55,534	247,075

[p] Preliminary.

Table 48.—Canada: Copper production (all sources) by Province[1]

(Short tons)

Province	1971 [r]	1972 [p]
British Columbia	140,310	247,855
Manitoba	55,264	58,511
New Brunswick	10,266	9,473
Newfoundland	13,980	10,621
Northwest Territories	689	602
Nova Scotia	16	--
Ontario	302,370	288,231
Quebec	184,823	172,190
Saskatchewan	11,146	13,138
Yukon Territory	2,566	--
Total	721,430	800,621

[p] Preliminary. [r] Revised.
[1] Blister copper plus recoverable copper in matte and concentrate exported.

Source: Dominion Bureau of Statistics, Department of Trade and Commerce, Dominion of Canada. Canada's Mineral Production, Preliminary Estimate. 1972.

Diatomite

By Benjamin Petkof [1]

Domestic diatomite production in 1972 increased 8% in quantity and 9% in value compared with 1971 figures. The United States maintained its status as a major world diatomite producer. Exports of processed diatomite to countries throughout the world increased significantly in quantity and value over those of 1971.

DOMESTIC PRODUCTION

Production increased in the major producing States of California and Nevada, but declined in Arizona and Oregon and remained unchanged in Washington. California retained its place as the largest producing State, followed by Nevada, Washington, Arizona, and Oregon.

During 1972 nine companies, with a total of 11 operations, mined and prepared diatomite for various industrial end uses. This was an increase of one producing company from the number reported in 1971. The bulk of the diatomite produced during the year was supplied by the following companies: Johns-Manville Products Corp., with facilities near Lompoc, Calif.; GREFCO, Inc., with operations near Mina, Nev., and Lompoc, Calif.; Eagle-Picher Industries, Inc., with operations near Sparks and Lovelock, Nev.; and Kenite Corp., Division of Whitco Chemical Corp., with an operation near Quincy, Wash. The remaining producers were: Superior Company near San Manuel, Ariz.; Basalt Rock Co. Inc., near Napa, Calif.; Airox, Inc., near Santa Maria, Calif.; The United Sierra Division, Cyprus Mines Corp. near Fernley, Nev.; and A. M. Matlock near Christmas Valley, Oreg. The Kenite Corp. completed an expansion program at the Quincy, Wash. plant with the addition of a new larger kiln and an air classifier.

A new pattern has appeared in the domestic distribution of diatomite filter aid that partially replaces the bagged shipment of the processed diatomite. A bulk distribution station was established at Rollins Terminals in Norristown, Pa., by the Celite Division of the Johns-Manville Products Corp. Prepared filter aid will be shipped from Lompoc, Calif., to Norristown in bulk pneumatic discharge hopper cars, unloaded into silos, and shipped in bulk truck loads to consumers in the eastern United States.

Johns-Manville Products Corp. also announced the introduction of a system to recover spent diatomite filter aid. The system recovers up to 60% of the filter aid from the filter cake using either a batch or continuous method of operation.

[1] Physical scientist, Division of Nonmetallic Minerals.

Table 1.—Diatomite sold or used by producers in the United States

	1966–68 [1]	1969	1970	1971	1972
Domestic production (sales) short tons	1,881,877	598,482	597,636	535,318	576,089
Average value per ton	$54.18	$60.96	$54.63	$64.25	$65.19

[1] Annual figures are confidential, prior to 1969.

CONSUMPTION AND USES

All major end uses reported significant increases in consumption. However, the percentage of total consumption for each end use varied only slightly from that of 1971. Filtration, the major end use of prepared diatomite, required almost three-fifths of the total material sold or used by producers in 1972. The remainder was used for industrial fillers, insulation, lightweight aggregates, pozzolans, soil conditioners, and other miscellaneous uses.

Table 2.—Domestic consumption of diatomite, by principal use, in percent of total consumption

Use	1968	1969	1970	1971	1972
Filtration	55	58	58	59	58
Fillers	21	20	19	W	W
Insulation	4	4	4	3	4
Miscellaneous	20	18	19	38	38

W Withheld to avoid disclosing individual company confidential data, included with "Miscellaneous."

PRICES

The weighted average value per ton of diatomite for all end uses in 1972, increased only slightly from that of 1971. Small increases in value per ton were reported for almost all end uses except for the abrasives which declined 10%.

Table 3.—Average annual value per ton of diatomite, by use

Use	1971	1972
Filtration	$72.64	$73.08
Insulation	45.34	47.02
Abrasives	139.04	125.27
Fillers	65.92	69.37
Lightweight aggregate	42.97	43.07
Miscellaneous	37.91	39.01
Weighted average	64.25	65.19

FOREIGN TRADE

Exports of prepared diatomite increased 4% in quantity and 7% in value over that of 1971 after declining since 1969. Major countries of destination for these exports were: Canada 25%; West Germany 11%; Japan 9%; the United Kingdom 8%; Australia 6%; Italy 4%; and Republic of South Africa 3%. The remainder was exported to many other developed and undeveloped countries of the world. The average value of exported material was $85.16 per ton. Imports of crude or processed material totaled 63 tons valued at $9,440. This material was imported from Mexico, Kenya, Canada, the United Kingdom, and West Germany. These imports were probably used to evaluate the diatomite deposits of these countries.

Table 4.—U.S. exports of diatomite

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1970	154	12,363
1971	142	11,752
1972	148	12,603

WORLD REVIEW

Overall world production of diatomite remained relatively unchanged from that of the previous year.

Increasing cost of transportation has tended to inhibit the growth of exports of domestically prepared diatomite during the past few years. This situation has stimulated interest in other deposits throughout the world. As a result of this trend the Johns-Manville Products Corp. has begun operating diatomite deposits at Murat, France, and Elch de la Sierra, Spain.

Iceland continued to produce and export diatomite for use as a high-quality filter aid. About one-third of the material exported is sent to West Germany, with the remainder distributed to countries that are mostly in western Europe.

Table 5.—Diatomite: World production by country
(Short tons)

Country	1970	1971	1972 p
North America:			
Canada e	480	500	500
Costa Rica	r 20,944	23,149	e 23,000
Mexico	25,127	24,233	e 25,000
United States	597,636	535,318	576,089
South America:			
Argentina	9,070	10,568	e 10,600
Colombia	309	331	e 330
Peru	r 2,820	e 3,000	e 3,000
Europe:			
Austria	4,158	3,400	e 3,400
Denmark:			
Diatomite e	22,000	22,000	22,000
Moler e	240,000	240,000	240,000
Finland	734	e 770	e 770
France	176,152	e 190,000	e 190,000
Germany, West (marketable)	100,924	97,787	63,985
Iceland	14,593	21,385	e 22,000
Italy	65,279	e r 65,000	e 65,000
Portugal	3,522	5,118	1,827
Spain	20,434	e 22,000	e 22,000
Sweden	6,471	5,585	e 5,500
U.S.S.R. e	410,000	410,000	420,000
United Kingdom	15,170	e 15,500	e 15,500
Africa:			
Egypt, Arab Republic of	2,564	2,480	e 2,400
Kenya	1,765	1,543	e 1,500
South Africa, Republic of	935	358	346
Asia: Korea, Republic of	2,848	3,486	e 3,500
Oceania:			
Australia	r 2,928	1,534	e 1,300
New Zealand	6,485	6,986	e 7,000
Total	r 1,753,348	1,712,031	1,726,547

e Estimate. p Preliminary. r Revised.

TECHNOLOGY

A mixture has been developed using diatomite as a mineral carrier and containing a degreasing fluid such as trichlorethylene, tetrachlorethylene, or carbon tetrachloride for removing oil, grease, or fat on road, floor, and water surfaces. The mixture can also include a small quantity of synthetic detergent or other surface active material. Floating oil, when treated with this formulation sinks to the sea bottom causing no apparent effect to fish, birds, and other sea life.[2]

[2] Marel, Guy. Mixture for eliminating oil, grease, or fat on road, floor or water surfaces. Brit. Pat. 1,273,971.

Feldspar, Nepheline Syenite, and Aplite

By J. Robert Wells [1]

Domestic production and consumption of crude feldspar declined slightly in 1972, amounting to 99% of the respective 1971 figures and to 97% of those for the record year 1969. Simultaneous increases in utilization of both domestic aplite and imported nepheline syenite, however, brought the 1972 total U.S. consumption of the three feldspathic materials substantially above the corresponding total for 1971 and even farther above that for 1969. A notable feature of the 1972 feldspar situation was the sharp drop in ground feldspar imports, although again that decrease was more than balanced by increased imports of nepheline syenite.

Until about World War I it was customary to report all feldspar statistics, both crude and ground, in terms of short tons, but at that time it became the practice to record crude feldspar production, imports, and consumption in long tons. It is now felt that any advantages of that system have long been outweighed by the difficulty of direct comparisons and by the multiple opportunities for confusion, and that a return to the earlier practice is justified. Beginning with the present 1972 Minerals Yearbook chapter, all feldspar and nepheline syenite data, without exception will be reported in short tons.

Legislation and Government Programs.—According to provisions of the Tax Reform Act of 1969, which continued in force throughout 1972, 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

	1968	1969	1970	1971	1972
United States:					
Crude:					
Sold or used by producers.....short tons..	747,800	754,863	726,069	742,810	732,439
Value.................thousands..	$8,265	$8,869	$9,638	$9,969	$10,372
Average value per short ton.......	$11.05	$11.75	$13.27	$13.42	$14.16
Imports for consumption.....short tons..	--	52	252	134	187
Value.................thousands..	--	$7	$23	$19	$23
Average value per short ton.......	--	$134.62	$91.27	$141.79	$123.00
Consumption, apparent [1].....short tons..	747,800	754,915	726,321	742,944	732,626
Ground:					
Sold by merchant mills.......short tons..	730,737	793,052	647,995	601,618	580,801
Value.................thousands..	$9,242	$10,465	$9,458	$8,716	$8,990
Average value per short ton.......	$12.65	$13.20	$14.60	$14.48	$15.48
Exports...................short tons..	14,326	6,325	5,570	3,984	5,275
Value.................thousands..	$366	$358	$195	$141	$184
Average value per short ton.......	$25.55	$56.60	$35.01	$35.39	$34.88
Imports for consumption.....short tons..	3,782	5,201	3,637	2,375	945
Value.................thousands..	$91	$128	$93	$65	$20
Average value per short ton.......	$24.06	$24.61	$25.57	$27.38	$24.34
World: Production..........thousand short tons..	2,473	2,697	2,786	2,749	2,635

[1] Measured by quantity sold or used by producers plus imports.

FELDSPAR

DOMESTIC PRODUCTION

Crude Feldspar.—North Carolina, for many years in first place and without close rival as a feldspar-producing State, scored a fifth consecutive annual increase in tonnage in 1972, reaching a point 12% above the output of 1971 and 48% above that of 5 years ago. North Carolina was followed in descending order of tonnage by California, Connecticut, South Carolina, and Georgia. The other four producing States (Arizona, Colorado, South Dakota, and Wyoming) together contributed 2% of the national totals for tonnage and value.

Leading 1972 producers of feldspar were the Feldspar Corp., from mines in Mitchell County, N. C., Middlesex County, Conn., and Jasper County, Ga.; International Minerals & Chemical Corp., from mines in Mitchell County, N. C., and Mohave County, Ariz. (the latter sold in mid-1972);

Table 2.—Crude feldspar sold or used by producers in the United States

(Short tons and thousand dollars)

Year	Hand-cobbed		Flotation concentrate		Feldspar-silica mixtures [1]		Total [2]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1968	87,809	670	479,102	5,845	180,889	1,750	747,800	8,265
1969	67,967	494	371,301	4,912	315,595	3,462	754,863	8,869
1970	52,770	543	415,075	5,395	258,224	3,699	726,069	9,638
1971	45,258	749	442,823	5,454	254,728	3,766	742,810	9,969
1972	25,259	392	535,058	7,354	172,122	2,627	732,439	10,372

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

Table 3.—Production of ground feldspar, by use

(Short tons and thousand dollars)

Use	1971		1972	
	Quantity	Value	Quantity	Value
Hand-cobbed:				
Glass	W	W	1,800	45
Pottery	12,294	285	12,186	263
Enamel	W	W	8,371	165
Soap	W	W	2,627	55
Other	24,435	530	168	4
Total	36,729	815	25,152	532
Flotation concentrate:				
Glass	W	W	256,584	3,034
Pottery	174,660	2,902	196,443	3,631
Other	255,513	2,760	5,614	127
Total	430,173	5,662	458,641	6,792
Feldspar-silica mixture:[1]				
Glass	W	W	29,352	347
Pottery	W	W	49,284	778
Other	134,716	2,238	18,372	543
Total	134,716	2,238	97,008	1,668
Total:				
Glass	306,919	3,533	287,736	3,426
Pottery	W	W	257,913	4,672
Enamel	W	W	8,371	165
Soap	W	W	2,627	55
Other [2]	294,699	5,183	24,154	674
Total [3]	601,618	8,716	580,801	8,990

W Withheld to avoid disclosing individual company confidential data; included with "Other."
[1] Feldspar content.
[2] Includes plastics, refractories, and rubber.
[3] Data may not add to totals shown because of independent rounding.

and Lawson-United Feldspar and Mineral Co., from mines in Mitchell County, N. C.

In 1972, 73% of the total tonnage of feldspar sold or used by producers was flotation concentrate, 24% was feldspar in feldspar-silica mixtures, and only 3% was hand-cobbed, the lowest such proportion since comparable statistics have been kept. The respective corresponding figures for 1971 were 60%, 34%, and 6%; for 1962 they were 66%, 11%, and 23%. Prior to 1952, hand-cobbed feldspar comprised virtually the entire output.

Ground Feldspar.—Most of the feldspar used in glassmaking is ground no finer than 20 mesh, but feldspar to be used in ceramics and filler applications is usually pulverized to minus 200 mesh or finer. Ten companies, operating 14 plants in eight States, ground feldspar for market in 1972, supplying ground material (total tonnage 3% less than in 1971) for shipment to destinations in at least 25 States and a number of foreign countries. Listed in descending order of output tonnages, North Carolina had six grinding mills, while Connecticut, South Carolina, and Georgia had one each. These were the leaders in ground feldspar production and jointly accounted for 94% of the 1972 total. California with one mill, South Dakota with two, Arizona with one, and Wyoming with one, were the four States making up the remaining 6%. Colorado was the only crude feldspar-producing State in 1972 in which no grinding mill was operated.

CONSUMPTION AND USES

Crude Feldspar.—In 1972 there was, as usual, no significant domestic consumption of feldspar in the raw, unprocessed state in which it was taken from the mine; the majority of users purchased their supplies of the mineral already ground and sized either by the primary producers or by merchant grinders. Some manufacturers of pottery, soaps, and enamels, however, continued their customary practice of acquiring relatively small quantities of crude feldspar for grinding to their preferred specifications in their own mills.

Ground Feldspar.—The 1972 pattern of ground feldspar consumption in the United States was not strikingly different from that of the previous year, but the confidential status of some of the 1971 data precludes a detailed comparison. The 1971 end-use distribution, insofar as it was publishable, showed that 51% of the total was consumed for glassmaking and 49% went for pottery, enamel, and miscellaneous uses, compared with 1972 data showing 50% for glass, 44% for pottery, and 6% for enamel and other uses. These data, compared with the averages recorded in the decade of the 1960's (55% for glass,

Table 4.—Ground feldspar shipped from merchant mills in the United States

(Short tons)

Destination	1968	1969	1970	1971	1972
Arkansas	W	W	W	W	5,148
California	W	W	W	W	22,863
Illinois	64,628	51,899	44,801	W	43,361
Indiana	25,897	21,944	23,853	25,344	26,869
Kentucky	10,180	9,077	15,004	8,732	14,978
Louisiana	W	W	W	W	21,176
Maryland	W	5,057	W	W	1,037
Massachusetts	3,896	4,072	W	W	W
Michigan	W	1,438	W	W	527
Mississippi	8,685	8,931	15,187	16,060	16,057
Missouri	W	--	--	W	4,595
New Jersey	W	W	W	W	44,425
New York	20,311	19,668	W	W	17,178
Ohio	87,202	120,756	94,010	56,783	63,472
Oklahoma	18,385	31,203	14,200	W	12,546
Pennsylvania	27,333	23,566	21,884	19,479	20,175
Tennessee	26,898	29,153	W	W	34,332
Texas	24,449	21,776	32,365	31,984	20,607
West Virginia	34,720	29,465	30,339	W	35,658
Wisconsin	--	--	W	--	6,775
Other destinations [1]	378,153	415,047	356,352	443,236	169,022
Total	730,737	793,052	647,995	601,618	580,801

W Withheld to avoid disclosing individual company confidential data; included with "Other destinations."
[1] Includes Colorado, Minnesota, Rhode Island, Washington, and States indicated by symbol W. Also includes exports to Canada, Mexico, and other countries.

30% for pottery, 4% for enamel, and 11% for other purposes), suggest a trend toward relatively greater consumption of feldspar for pottery and less for enamel and the other minor applications. In contrast, the proportion of feldspar consumption alloted to glass manufacture has remained comparatively stable since the early 1950's even though the container-glass industry has grown notably in the interim (shipments of glass containers more than doubled in volume from 1952 to 1972). The relatively static position of glass-grade feldspar in the consumption pattern appears to be a reflection of the progressively increasing utilization of imported nepheline syenite (seven times more tonnage in 1972 than in 1952) at the expense of feldspar, as a feldspathic material for glassmaking.

STOCKS

Comparison of the figures reported for 1972 domestic production and sales of feldspar indicated that industrial stocks of that mineral may have risen by approximately one-half during the year. It was estimated that U.S. producers had 440,000 short tons of mined feldspar on hand (crude, ground, or in process) on December 31, 1972, compared with 288,000 tons on that date in 1971 and 149,000 tons in 1970.

PRICES

Engineering and Mining Journal, December 1972, listed the following prices for feldspar per short ton, f.o.b. mine or mill, carload lots, bulk, depending on grade (substantially unchanged from the respective 1971 quotations):

North Carolina:	
20 mesh, flotation	$12.00
40 mesh, flotation	14.00– 21.00
200 mesh, flotation	21.50– 27.50
Georgia:	
40 mesh, granular	20.00
200 mesh	24.50
325 mesh	25.50
Connecticut:	
20 mesh, granular	15.50
200 mesh	22.50
325 mesh	23.50

Feldspar prices were quoted by Industrial Minerals (London), December 1972, as follows (converted from pounds sterling per long ton to dollars per short ton):

Ceramic grade, powder, 200 mesh, bagged, ex-store	$47– 51
Lump, imported, c.i.f. main European port	23– 28

As of July 3, 1972, International Minerals & Chemical Corp. (Canada), Ltd., increased prices for two classifications of its B-grade nepheline syenite (0.5% Fe_2O_3, used for various industrial purposes), minus 30-mesh material from $8.00 per ton to $8.60 per ton, and 40 DD material from $8.50 per ton to $9.15 per ton, in bulk, f.o.b. Blue Mountain, Ontario. Prices for the firm's low-iron grades (0.07% Fe_2O_3, used in the making of glass and fine ceramics) ranged up to $22.00 per ton.

Ceramic Industry Magazine, January 1973, quoted prices for aplite in the range from $6.30 to $12.40 per ton.

Although the foregoing quotations presumably were indicative of price ranges, it is to be understood that most actual sales of feldspar and feldspathic materials in 1972 were concluded as is customary both in the United States and abroad, at negotiated prices not on public record.

FOREIGN TRADE

In 1972, U.S. exports included 5,275 short tons of material indeterminately classified as feldspar, leucite, nepheline, or nepheline syenite (but presumably all or mostly feldspar) with a total value of $183,649, up 32% and 30% from the respective comparable figures for 1971.

Statistics on U.S. feldspar imports, substantially all from Canada, were first reported in a separate category toward the end of 1922. Thereafter, feldspar imports (with the exception of those in the depression years 1932 and 1933) averaged in the neighborhood of 20,000 short tons per year until 1952, when large-scale domestic production of flotation concentrate feldspar overturned existing market patterns. After 1957, imports of feldspar in all forms held relatively steady around an annual average of 4,500 tons, but fell to 2,509 tons in 1971 and (coinciding with the closure of Canada's only remaining feldspar mine) to 1,132 tons in 1972. Imports of Canadian nepheline syenite (one of feldspar's most effective competitors as a feldspathic material) amounted in 1972 to 11% more quantity and 16% more total value than in 1971, the eleventh in a consecutive series of annual increases, pointing to an obvious rationale for feldspar's reciprocally waning significance as an import item. In 1972, U.S. imports included, besides materials definitely in the feldspathic cate-

Table 5.—U.S. imports for consumption of feldspar

Country	1971 Short tons	1971 Value	1972 Short tons	1972 Value
Crude: Canada	134	$19,020	187	$23,105
Ground, crushed or pulverized:				
Canada	2,051	54,858	748	16,940
Japan	1	432	--	--
Mexico	16	288	--	--
Sweden	121	4,230	49	1,742
United Kingdom	186	5,113	148	1,125
Total	2,375	64,921	945	19,807

gory, 4,700 short tons of material valued at $305,227 and classified as "natural mineral fluxes, crushed, ground, or pulverized," at least part of which may have been consigned to uses similar to those served by feldspar.

The tariff schedule in force throughout 1972 provided for a 3½% ad valorem duty on ground feldspar. Imports of crude feldspar and of nepheline syenite, crude or ground, were not subject to duty.

WORLD REVIEW

Significant quantities of feldspar were produced in 1972 in at least 35 countries. Feldspar flotation plants were in essentially full-time operation in the United States, Finland, Mexico, and Norway, while dry grinding of feldspar was reported in the United States, France, Italy, and West Germany. Other countries, including several in the Communist group, also processed the mineral in local facilities for their own domestic industries. Nepheline syenite was produced in Canada, mainly for consumption in the United States, and in Norway for markets in western Europe. The U.S.S.R. probably had substantial production of this material also, but definite information was not published.

Brazil.—Feldspar was produced from pegmatitic deposits in east and southeast Brazil and was used in the major industrial centers, especially São Paulo and Rio de Janeiro, mostly for the manufacture of glass and ceramics. Specific data were not released, but the year's output was estimated to lie somewhere in the range of 70,000 to 80,000 tons.

Canada.—International Minerals & Chemical Corp. (Canada), Ltd., Canada's only feldspar producer in recent years, suspended operations at its Buckingham plant in Quebec, reportedly because of declining demand for that mineral. That same firm is Canada's second-largest producer (after Indusmin, Ltd., a subsidiary of Falconbridge Nickel Mines, Ltd.) of the leading alternative feldspathic material, nepheline syenite.

Germany, West.—Besides being among the world's top two or three feldspar producers, West Germany is also a large importer of feldspathic materials. Imports of feldspar, leucite, and nepheline syenite totaled 90,000 short tons in 1970 and 97,000 short tons in 1971. At Hirschau (Bavaria) in what is now West Germany, a private company was founded in 1895 by the Dorfner brothers for manufacturing stoneware and mining kaolin to use as a raw material. The enterprise has remained in the hands of succeeding generations of the same family for nearly eight decades, although making of stoneware stopped in 1920. Present activities of the company concentrate on the mining, processing, and marketing of water-washed kaolin, ground quartz, quartz sands, and potash feldspar.

India.—Total minehead value of India's 1971 production of feldspar was reported at 336,000 rupees, equivalent to $45,000, compared with 275,000 rupees ($37,000) in 1970. Exports accounted for 31% of the output in 1971 (36% in 1970), but different systems of reporting preclude a direct comparison between value of exports and value of production.

Israel.—One of the announced results of a 5-year scientific survey of the Sinai Peninsula was the discovery of a large feldspar deposit (described as "a whole mountain several kilometers square"). No analysis was mentioned, but quality of the mineral was said to be good. The site of the discovery, "only half an hour's drive from Sharm el-Sheikh," would seem to justify rating the deposit as a potentially valuable resource for the not-distant future.

Italy.—In 1971, last year for which data have been released, Italy exported 30,000 short tons of feldspar, 4% more than in 1970. West Germany and Greece were, as usual, the principal recipients of the exported mineral.

Norway.—Norway customarily exports more than half her feldspar output and a much larger share of her production of nepheline syenite. Feldspar output in 1971 was 165,000 short tons, of which 87,500 short tons (53%) was exported; nepheline syenite production was 176,500 short tons, of which nearly all (98%) was shipped to foreign destinations.

South Africa, Republic of.—In a catalogue of working mines, as of December 31, 1969, 11 mines were listed as producing feldspar. Mica and silica were mentioned as coproducts from a number of those operations. Active feldspar mines were situated in the Namaqualand district (one mine) and the Kenhardt district (two mines) of Cape Province; and the Lataba district (eight mines) of Transvaal Province. About 70% of the 1970 feldspar production was exported (14,500 out of 20,800 short tons), while in 1971 exports slightly exceeded the year's mine output (13,500 short tons produced, 13,600 short tons exported).

United Kingdom.—Charter Exploration, Ltd., a London-based mining firm, announced plans to undertake the mining

Table 6.—Feldspar: World production by country

(Short tons)

Country [1]	1970	1971	1972 p
North America:			
Canada (shipments)	10,656	10,774	10,000
Mexico	r 94,518	109,506	e 110,000
United States (sold or used)	726,069	742,810	732,439
South America:			
Argentina	32,558	39,996	e 40,000
Chile	3,968	992	1,771
Colombia	25,521	27,377	29,055
Peru	3,156	e 3,300	e 3,300
Uruguay	1,218	1,332	1,070
Europe:			
Austria	1,329	2,928	3,391
Finland	68,482	70,616	65,982
France	r 260,000	212,000	146,000
Germany, West	450,634	389,879	336,814
Italy	r 195,004	212,192	193,805
Norway [2]	167,711	e 165,000	e 165,000
Poland e	33,000	33,000	33,000
Portugal	33,961	20,691	17,187
Spain [3]	60,720	68,050	e 68,000
Sweden	r 35,180	e 35,000	e 35,000
U.S.S.R. e	276,000	276,000	287,000
United Kingdom (china stone) e	37,000	37,000	37,000
Yugoslavia	54,568	59,103	e 61,000
Africa:			
Egypt, Arab Republic of	1,970	3,495	e 3,300
Kenya	987	2,921	2,163
Malagasy Republic	1	NA	NA
Mozambique	32,690	17,960	16,085
South Africa, Republic of	20,829	13,492	27,912
Asia:			
Burma	[4] 895	[4] 766	881
Hong Kong	1,787	1,262	1,267
India	r 32,656	48,762	54,991
Japan [5]	64,354	57,843	63,662
Korea, Republic of	30,998	18,615	31,939
Pakistan (formerly West-Pakistan)	152	336	265
Philippines	22,306	61,539	50,774
Sri Lanka (formerly Ceylon)	1,425	284	638
Oceania: Australia	r 3,896	4,017	e 4,000
Total	r 2,786,199	2,748,838	2,634,691

e Estimate. p Preliminary. r Revised. NA Not available.

[1] In addition to the countries listed, Brazil, People's Republic of China, Czechoslovakia, Romania and Territory of South-West Africa produce feldspar, but available information is inadequate to make reliable estimates of output.

[2] Described in source as lump feldspar; does not include nepheline syenite as follows, in short tons: 1970—162,088; 1971—176,470; 1972—e 176,000.

[3] Includes pegmatite.

[4] Data are for years ending June 30 of that stated.

[5] In addition the following quantities of aplite and saba were produced: aplite: 1970—514,508; 1971—448,162; 1972—501,648; saba: 1970—10,748; 1971—6,005; 1972—1,336.

and processing of feldspar from a newly discovered deposit, near Durness in Scotland's Sutherland County. The deposit contains at least 2 million tons of recoverable mineral of industrial quality. It was anticipated that expenditure of $1.2–$1.7 million would be sufficient to set up facilities to initiate operations at the rate of 50,000 tons per year. At present, all feldspar consumed in the United Kingdom is obtained by importation, mostly from Finland, Norway, and Yugoslavia.

A symposium, designated as the Advanced Study Institute on Feldspars, was held at the University of Manchester in July 1972. Membership of the Institute, which was sponsored by NATO, consisted of lecturers and students, many of whom presented research papers dealing with specific aspects of the study of feldspars and related disciplines. Publication of the Institute's act was expected in late 1972 or early 1973.

TECHNOLOGY

Magazine articles were published that outlined the mining, milling, and flotation procedures being used by a West German firm in the production of a number of ceramic raw materials including 18,000 tons per year of glass-grade feldspar,[2] and by a company in Finland that has an annual output of 70,000 tons of feldspar concentrate and 30,000 tons of quartz concentrate for the making of glass and ceramics.[3]

The technological aspects of the selection, quality control, and preparation of ceramic materials, including feldspar, and of their fabrication into special-purpose insulators were some of the subjects dealt with in a journal article.[4] Feldspar was one of the raw materials mentioned in a magazine article as an ingredient in body formulations for efficient production of ceramic tile.[5] Important advances in whiteware firing technology were discussed in an industrial journal. It was stated that, for best results, the fluxes used have to be specially selected. Economy of soaking time at maximum temperature, for example, was achieved by the use of nepheline syenite in lieu of feldspar in the body mixtures.[6]

Although porcelain enameling on metal has been a feature of a number of human cultures for at least twenty centuries, no end is yet in sight for advances in this ancient art. Feldspar in varying proportions enters into most enamel formulas, and the permutations of those variations with the large number of other compositional possibilities permits the compounding of literally thousands of different types of enamel frits suitable for a range of applications extending from multicolored jewelry for personal adornment to large expanses of weather-resistant paneling for major buildings. How well porcelain enameling is keeping pace with today's metallurgical and structural progress was the subject of a journal article.[7]

The one most important outlet for feldspathic materials is in the manufacture of glass bottles and jars to contain beverages, foods, and pharmaceutical products. A substantial majority of such containers, for reasons of convenience and even of actual economy, are discarded after a single use. Salvaged glass, crushed to sand size and amounting to 5 percent of the furnace charge, was mixed with customary raw materials at a Pennsylvania glass works and melted down in a 24-hour, commercial-scale test to produce 3½ thousand gross of new beverage bottles. The waste glass for this successful test, of which the environmental and conservational implications are obvious, was recovered from city incinerator residues by a process and in a pilot plant both developed by the Bureau of Mines. As another part of its continuing research program in quest of advantageous outlets for scrap glass, the Bureau of Mines issued a report concerning experimental production of glass wool from the glass fractions of urban solid waste.[8]

A booklet[9] published by an association of concerned industrialists presented a chalk-talk discussion of the contribution of container glass to the urban refuse situation and outlined some of the association's

[2] Industrial Minerals (London). Operations of Gebruder Dorfner at Hirschau. No. 53, February 1972, pp. 17–19.

[3] Mining Magazine (London). Finnish Feldspar Plant. V. 127, No. 5, November 1972, pp. 439, 441.

[4] Jordan, Roy E., Jr. Ceramic Insulator Co.: Newcomer With Experience. Ceram. Age, v. 88, No. 3, March 1972, pp. 11–12, 21.

[5] Ceramic Industry Magazine. The Ideal Tile Plant! V. 99, No. 2, pp. 36–37.

[6] Harkort, Dietrich, and Ulrich Hoffman. Germany Streamlines Firing Operations. Ceram. Ind. Mag., V. 99, No. 4, October 1972, pp. 26–29.

[7] Spencer-Strong, G. H. Porcelain Enamels—A Concept in Transition. Materials Research and Standards, v. 12, No. 4, April 1972, pp. 20–23.

[8] Goode, Alan H., M. E. Tyrrell, and I. L. Feld. Glass Wool From Waste Glass. BuMines Rept. of Inv. 7708, 1972, 16 pp.

[9] Glass Container Manufacturers Institute, Inc. The Solid Waste Fact Book. New York, 1972, 27 pp.

activities that are being devoted to efforts to defuse that component of the problem. Toward that end, the organization has undertaken a program to investigate the possibilities, technologies, and economic involvements of the salvaging and reutilization of waste container glass in potentially profitable enterprises. Goals of this research include the development of economical processes for mechanically separating glass from other solid wastes, for using the maximum amount of the material so recovered in the making of new glass containers, and for channeling the rest into commercially viable applications.

A number of articles appeared in industrial journals that dealt with the current status of glass recycling technology.[10] Possible applications for the reclaimed material were discussed that, in addition to the reworking into new containers, included use in the production of road-surfacing aggregates, building blocks, bricks, structural panels, terrazzo tiles for flooring, sewer and drain pipes, insulating materials, and decorative or light-reflecting paints. Also mentioned were several smaller scale uses ranging from costume jewelry to poultry grit.

NEPHELINE SYENITE

Nepheline syenite is a feldspathic igneous rock with a texture similar to that of granite that is extensively used in place of feldspar as an alumina-bearing raw material for glassmaking and in the whitewares industry both as a body component and in frits for glazing. In a relatively recent development, increasing quantities of nepheline syenite are being ground to extreme fineness for use as a filler in plastics, foam latex products, paper, and paint. Nepheline syenite mined in the United States (Arkansas) is used only as stone (mostly for roofing granules or road metal); all nepheline syenite consumed here for glass and ceramics is imported from Canada, the world's foremost producer. Canada's 1972 shipments of nepheline syenite (all from two operations at Blue Mountain, Ontario) were estimated at 560,000 short tons, valued at $7.07 million. The average unit values reported for Canadian production and U.S. imports of ground nepheline syenite in 1972 were $12.62 and $12.45 per short ton, respectively, or about 5% more than the comparable figures for 1971. The world's second-largest producer of glass- and ceramic-grade nepheline syenite is Norway; shipments from that source in 1971 amounted to 165,000 short tons. The U.S.S.R. also mines nepheline syenite on a commercial scale, but reportedly the output is used only for production of metallurgical-grade alumina.

Table 7.—U.S. imports for consumption of nepheline syenite

Year	Crude		Ground	
	Short tons	Value (thousands)	Short tons	Value (thousands)
1970	603	$2	395,289	$4,634
1971	636	12	413,862	4,912
1972	3,027	43	456,406	5,681

APLITE

Aplite is a granitic rock with a high proportion of albite (soda feldspar) or plagioclase (lime-soda feldspar), either of which makes it potentially useful as a raw material for the manufacture of container glass. To become acceptable for that purpose, however, the mined material usually must first be processed to eliminate all but a trace of the iron-bearing minerals it contains. Aplite of glassmaking quality was produced in the United States in 1972 from two open pit mines in central Virginia. The Feldspar Corp. mined aplite ore near Montpelier, Hanover County, and removed iron from it by an electrostatic process. International Minerals & Chemical

[10] Svec, J. J. Industry Involvement Speeds Glass Recycling. Ceram. Ind. Mag., v. 96, No. 2, February 1971, pp. 22–24.
Hanot, William. 40 Years of Recycling. Am. Ceram. Soc. Bull., v. 51, No. 6, June 1972, pp. 519–522.
Pincus, Alexis G. Recycling High on Glass Horizon. Glass Ind., v. 53, No. 6, June 1972, p. 10.
Environmental Science & Technology. Building Bricks From the Waste Pile. V. 6, No. 6, June 1972, pp. 502–503.
Shutt, T. C., H. Campbell, and J. H. Abrahams, Jr. New Building Materials Containing Waste Glass. Am. Ceram. Soc. Bull., v. 51, No. 9, September 1972, pp. 670–671.
Environmental Science & Technology. Glass Recycling Makes Strides. V. 6, No. 12, November 1972, pp. 988–990.

Corp. operated a mine near Piney River, Nelson County, and subjected the crude aplite to a high-intensity treatment to separate iron minerals. Aplite mine production in 1972 continued the upward trend of recent years and was 6% greater in tonnage than in 1971, although the reported total value was sharply lower. Specific annual data on aplite production, sales, and value have not been released for publication since 1962. That year's output was 140,000 short tons, valued at $0.9 million.

Ferroalloys

By Norman A. Matthews [1]

The overall structure of the domestic ferroalloy industry did not change basically during 1972. Management elected to close some older plants rather than invest heavily in the pollution control equipment necessary to meet the stringent emission requirements projected for 1976. The volume of business improved at yearend as the principal consumers of ferroalloys, the steel, cast iron, and aluminum industries, approached capacity operations. However ferroalloy imports increased to such a degree that total domestic shipments remained practically unchanged compared to those of 1971. Exports of ferroalloys continued to decline with the total volume reduced 43,000 tons (49%), whereas value declined only $3 million as the export product mix changed considerably. Published prices were generally constant during the year but did not govern in many of the major commodities as domestic producers acted to counter prices of imported products.

Detailed information concerning utilization of individual elements in various alloy products may be found in the chromium, manganese, silicon, molybdenum, nickel, tungsten, and vanadium chapters.

[1] Physical scientist, Division of Ferrous Metals.

Table 1.—Government inventory of ferroalloys (stockpile grade), December 31, 1972

(Thousand short tons)

Alloy	National (strategic) stockpile	CCC and supplemental stockpile	Total
Ferrochromium:			
High-carbon	126	276	402
Low-carbon	128	191	319
Ferrochromium-silicon	26	33	59
Ferrocolumbium (contained columbium)	0.7	--	0.7
Ferromanganese:			
High-carbon	143	1,033	1,176
Medium-carbon	29	--	29
Ferromanganese-silicon	23	--	23
Ferromolybdenum (contained molybdenum)	4	--	4
Ferrotungsten (contained tungsten)	1	--	1
Ferrovanadium (contained vanadium)	1	--	1

Table 2.—Ferroalloys produced and shipped from furnaces in the United States

	1971				1972			
	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 [1]	759,896	78.6	799,593	$134,594	800,723	78.3	726,592	$126,598
Silicomanganese	164,682	66.0	144,062	28,064	153,234	65.3	146,433	28,440
Ferrosilicon [2]	687,166	64.2	678,369	155,850	841,386	59.8	784,399	182,100
Silvery pig iron	171,778	17.7	174,160	15,902	163,073	20.8	163,714	14,800
Chromium alloys:								
Ferrochromium:								
High-carbon	248,165	68.3	252,766	100,841	169,525	65.0	162,718	39,688
Low-carbon					69,003	69.1	81,043	38,581
Ferrochromium silicon	107,493	44.0	102,009	36,518	98,223	42.4	90,986	25,974
Other alloys [3]					15,554	53.0	17,293	7,031
Total	355,658	61.0	354,775	137,359	352,305	62.0	352,040	111,274
Ferrotitanium	3,363	28.2	3,094	3,261	3,650	25.7	4,133	4,566
Ferrophosphorus	101,353	24.0	89,252	4,527	130,355	23.9	118,454	5,739
Ferrocolumbium	830	61.4	1,627	7,204	1,160	63.5	2,431	11,656
Other [4]	86,329	44.1	81,275	71,579	80,738	44.2	81,598	82,416
Grand total	2,331,055	62.6	2,326,207	558,340	2,526,624	61.8	2,379,794	567,589

[1] Includes briquets and fused-salt electrolytic.
[2] Includes silicon metal and inoculant type alloys.
[3] Includes chromium briquets, chromium metal, exothermic chromium additives, and other miscellaneous chromium alloys.
[4] Includes ferroboron, and other complex boron additive alloys, ferronickel, ferromolybdenum, ferrotungsten, ferrovanadium, spiegeleisen, ferrozirconium, and other miscellaneous alloys.

DOMESTIC PRODUCTION

The number of ferroalloy producers declined from 29 to 25 at yearend 1972. Agrico Chemical Co. closed its phosphorus and ferrophosphorus facility at Pierce, Fla., in August, and Hanna Furnace Corp., Division of National Steel Corp., Buffalo, N.Y., stopped producing silvery pig iron at yearend. The Ohio Ferro-Alloys Corp. plant at Tacoma, Wash., was closed late in the year and Foote Mineral Co. announced that it would close its plant at Steubenville, Ohio, in 1973. N L Industries, Inc. ceased production of specialty ferroalloys at its Niagara Falls, N.Y., plant at yearend as the facilities were converted to processing other commodities.

Alabama Metallurgical Corp., which produced ferrosilicon at Selma, Ala., merged with the Globe Metallurgical Division of Interlake Corp. and continued to operate as a part of the division.

Although production of wrought steel and iron castings increased 11% in 1972 compared with that of 1971, total domestic ferroalloy shipments did not change significantly, principally because of the increased volume of imported ferroalloys that went into the domestic market.

Union Carbide Corp's. Ferroalloys Division is installing a $7.6 million computer-controlled 45 MW ferrosilicon furnace at Astabula, Ohio, for completion in 1975. Projected capacity is 75,000 tons per year of 50% ferrosilicon. Otherwise the domestic industry is investing, at a maximum rate consonant with earnings, in pollution control equipment to meet the emission requirements projected for 1976.

Table 3.—Producers of ferroalloys in the United States in 1972

Producer	Plant location	Product [1]	Type of furnace
Agrico Chemical Co	Pierce, Fla	FeP	Electric.
Airco Alloys & Carbide	Calvert City, Ky; Charleston, S.C; Mobile, Ala; Niagara Falls, N.Y	FeCr, FeCrSi, FeMn, FeSi, SiMn.	Do.
Alabama Metallurgical Corp	Selma, Ala	FeSi	Do.
Bethlehem Steel Corp	Johnstown, Pa	FeMn	Blast.
Chromium Mining & Smelting Co	Woodstock, Tenn	FeMn, SiMn, FeCr, FeSi, FeCrSi.	Electric.
Climax Molybdenum Co	Langeloth, Pa	FeMo	Aluminothermic.
Diamond Shamrock Corp	Kingwood, W. Va	FeMn	Electric.
FMC Corp	Pocatello, Idaho	FeP	Do.
Foote Mineral Co	Cambridge, Ohio; Graham, W. Va; Keokuk, Iowa; Vancoram, Ohio; Wenatchee, Wash	FeB, FeCb, FeTi, FeV, FeCr, FeCrSi, FeSi, silvery iron, other.[2]	Do.
Hanna Furnace Corp	Buffalo, N.Y	Silvery iron	Blast.
Hanna Nickel Smelting Co	Riddle, Oreg	FeNi	Electric.
Hooker Chemical Corp	Columbia, Tenn	FeP	Do.
Interlake Steel Corp	Beverly, Ohio	FeCr, FeCrSi, FeSi, SiMn.	Do.
Kawecki Chemical Co	Easton, Pa	FeCb	Aluminothermic.
Mobil Chemical Co	Nichols, Fla	FeP	Electric.
Molybdenum Corp. of America	Washington, Pa	FeMo, FeW, FeCb, FeB.	Electric and aluminothermic.
Monsanto Chemical Co	Columbia, Tenn; Soda Springs, Idaho	FeP	Electric.
N L Industries, Inc	Niagara Falls, N.Y	FeTi, other [2]	Do.
New Jersey Zinc Co	Palmerton, Pa	Spln	Do.
Ohio Ferro-Alloys Corp	Brilliant, Ohio; Philo, Ohio; Powhatan, Ohio; Tacoma, Wash	FeCr, FeSi, FeB, FeMn, SiMn, other.[2]	Do.
Reading Alloys	Robesonia, Pa	FeCb, FeV	Aluminothermic.
Shieldalloy Corp	Newfield, N.J	FeV, FeTi, FeB, FeCb, NiCb, CrMo, other.[2]	Do.
Stauffer Chemical Co	Tarpon Springs, Fla; Mt. Pleasant, Tenn; Silver Bow, Mont	FeP	Electric.
Tennessee Alloys Corp	Bridgeport, Ala; Kimball, Tenn	FeSi	Do.
Tennessee Valley Authority	Muscle Shoals, Ala	FeP	Do.
Tenn-Tex Alloy Chemical Corp. of Houston.	Houston, Tex	FeMn, SiMn	Do.
Union Carbide Corp	Alloy, W. Va; Ashtabula, Ohio; Marietta, Ohio; Niagara Falls, N.Y; Portland, Oreg; Sheffield, Ala	FeB, FeCr, FeCrSi, FeCb, FeSi, FeMn, FeTi, FeW, FeV, SiMn, other.[2]	Do.
U.S. Steel Corp	Clairton, Pa; McKeesport, Pa	FeMn	Blast.
Woodward Iron Co	Woodward, Ala; Rockwood, Tenn	FeSi, FeMn, SiMn	Electric.

[1] CrMo, Chromium molybdenum; FeMn, ferromanganese; Spln, spiegeleisen; SiMn, silicomanganese; FeSi, ferrosilicon; FeP, ferrophosphorus; FeCr, ferrochromium; FeMo, ferromolybdenum; FeNi, ferronickel; FeTi, ferrotitanium; FeW, ferrotungsten; FeV, ferrovanadium; FeB, ferroboron; FeCb, ferrocolumbium; NiCb, nickel columbium; Si, silicon metal.

[2] Includes Alsifer, Simanal, zirconium alloys, ferrosilicon boron, aluminum silicon alloys, and miscellaneous ferroalloys.

CONSUMPTION AND USES

Consumption of the ferroalloys during melting, refining, and finishing of heats of steel increased proportionately to steel production in 1972, showing an 11% increase compared with that of 1971. Overall growth of additive alloys consumption for all uses was 13%, with a marked increase in silicon usage in the production of steel and cast iron.

Consumption of the ferroalloys as alloying elements increased 31% in 1972 compared with that of 1971, representing principally growth in the use of chromium and nickel in the production of stainless and alloy steels. Ferronickel is listed in the consumption table (table 5) for the first time, since the use of this form of nickel has increased substantially.

The consumption data for alloying elements listed in table 5 understates total consumption of several elements in most instances since it covers only the ferroalloy forms. Alloying elements such as nickel, molybdenum, tungsten, and vanadium may be added to metallic melts in any one of several forms. The practice varies as relative economics change and technological progress permits greater latitude in the choice of form of the alloying addition.

The following tabulation gives the proportion of the above alloying elements added in the ferroalloy state in relation to other product forms. It refers only to metallic products, neglecting chemicals and other end uses.

Element	Added as ferroalloy [1] (%)	Added in other forms (%)
Molybdenum	25	75
Nickel	19	81
Tungsten	16	84
Vanadium	92	8

[1] Modified as in notes to table 5.

For a more complete analysis of the consumption patterns, the reader is referred to the respective commodity chapters.

Table 4.—Consumption by end use of ferroalloys as additives in the United States in 1972

(Short tons of alloys)

Alloy	Stainless steels	Other alloy steels	Carbon steels	Tool steels	Cast irons	Superalloys	Alloys (excludes alloy steels and superalloys)	Other uses [1]	Total
Ferromanganese [2]	15,972	174,335	776,245	2,073	26,701	558	18,477	3,176	1,017,537
Silicomanganese	8,371	34,043	71,067	27	3,660	W	2,393	4,692	124,253
Silicon alloys [3]	28,219	67,259	162,164	2,692	543,869	314	71,357	66,260	942,134
Ferrotitanium [4]	366	720	894	W	87	489	1,583	2,030	6,169
Ferrophosphorous [5]	31	1,586	12,009	W	3,392	--	307	1,392	18,717
Ferroboron	4	346	--	--	9	--	--	9	368
Total	52,963	278,289	1,022,379	4,792	577,718	1,361	94,117	77,559	2,109,178

W Withheld to avoid disclosing individual company confidential data; included in "Other uses."
[1] Includes unspecified uses.
[2] Includes spiegeleisen, manganese metal, and briquets.
[3] Includes silicon metal, silvery iron, and inoculant alloys.
[4] Includes other forms such as scrap titanium metal.
[5] Includes other phosphorous materials.

Table 5.—Consumption by end uses of ferroalloys as alloying elements in the United States in 1972

(Short tons of contained elements)

Alloy	Stainless steels	Other alloy steels	Carbon steels	Tool steels	Cast irons	Superalloys	Alloys (excludes alloy steels and superalloys)	Other uses [1]	Total
Ferrochromium [2]	164,818	47,017	2,618	3,206	6,122	8,775	3,986	2,856	239,398
Ferromolybdenum [3]	844	1,050	100	487	1,382	162	402	62	4,489
Ferrotungsten [4]	53	55	--	432	1	48	27	3	619
Ferrovanadium [5]	22	3,251	474	607	57	14	59	9	4,493
Ferrocolumbium	310	757	366	W	--	249	15	24	1,721
Ferrotantalum-columbium	W	W	W	--	--	W	W	16	16
Ferronickel	16,788	5,004	--	--	272	251	490	1	22,806
Total	182,835	57,134	3,558	4,732	7,834	9,499	4,979	2,971	273,542

W Withheld to avoid disclosing individual company confidential data; included in "Other uses."
[1] Includes unspecified uses.
[2] Includes other chromium ferroalloys and chromium metal.
[3] Includes calcium molybdate but not molybdenum oxide.
[4] Includes melting base self-reducing tungsten.
[5] Includes other vanadium-carbon-iron ferroalloys.

STOCKS

Producers' stocks increased substantially at yearend compared with those at the end of 1971, with 80% of the increase in manganese alloys. There were also modest increases in chromium and phosphorus alloy stocks and a sizable percentage increase in ferrovanadium producer stocks.

Consumer stocks increased logically in relation to the volume of business for most commodities, showing a modest percentage increase for the large-volume commodities and a substantial percentage increase for ferronickel and ferromolybdenum.

Table 6.—Stocks of ferroalloys held by producers and consumers in the United States, December 31, 1972

(Short tons)

	Producer		Consumer	
	1971, gross weight	1972, gross weight	1971, gross weight	1972, gross weight
Manganese ferroalloys [1]	128,238	244,635	179,198	194,884
Silicon alloys [2]	130,231	130,637	124,914	133,581
Ferrochromium [3]	79,991	86,302	24,397	27,422
Ferrotitanium [4]	1,639	1,163	701	1,206
Ferrophosphorus [5]	53,911	59,226	3,333	4,173
Ferroboron	630	413	55	47
Total	394,640	522,376	332,598	361,313
	1971, contained element	1972, contained element	1971, contained element	1972, contained element
Ferromolybdenum [6]	W	W	588	793
Ferronickel	W	W	2,539	3,990
Ferrotungsten [7]	W	W	119	145
Ferrovanadium	1,187	1,743	544	623
Ferrocolumbium	349	488	379	407
Total	1,536	2,231	4,169	5,958

W Withheld to avoid disclosing individual company confidential data.
[1] Includes ferromanganese, siliconmanganese, spiegeleisen, and manganese metals.
[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.
[7] Includes melting base self-reducing tungsten.

PRICES

Published ferroalloy prices on the major items remained essentially constant during the year 1972 but such prices did not apply in many cases as domestic producers adjusted prices to compete more effectively with imports. Published prices on the major chromium-containing alloys were withdrawn by major producers in October and not quoted throughout the remainder of the year. The prices quoted for manganese, silicon, molybdenum, tungsten, columbium, and titanium-containing alloys were not changed significantly as imports exerted increasing downward pressure on prices in a finite market. Prices quoted for some vanadium alloys were increased 2% and 5% in July 1972, and the price quoted for ferronickel was increased 7% in December.

FOREIGN TRADE

The decrease in volume of U.S. exports continued as the number of competing countries with exportable surpluses increased. The most pronounced decreases were in ferrosilicon, ferrophosphorus, and ferrovanadium. There were substantial increases in the volume of ferromanganese and ferrochromium exports. The total dollar value of exports declined from $23 million in 1971 to $20 million in 1972.

In contrast, the volume of imports increased substantially overall and most markedly in the major commodities, ferrochromium, ferromanganese, and ferrosilicon, involving respective increases of 66%, 44%, and 57%. The volume of ferronickel imports doubled as the total volume and value of imports in 1972 increased 56% and 66%, respectively, compared with those of 1971.

Table 7.—U.S. exports of ferroalloys

Alloys	1970		1971		1972	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
Ferrocerium and alloys	39	$275	30	$164	101	$610
Ferrochromium	28,373	8,259	9,164	3,620	12,861	4,342
Ferromanganese	21,747	4,356	4,526	1,205	6,842	1,512
Ferromolybdenum	1,007	3,088	677	1,978	454	1,163
Ferrophosphorous	33,106	1,199	35,111	1,419	1,179	111
Ferrosilicon	44,694	11,887	25,506	5,603	7,367	2,196
Ferrotungsten [1]	--	--	60	411	11	85
Ferrovanadium	2,154	12,127	1,351	3,490	269	1,256
Ferroalloys, n.e.c.	19,964	14,486	10,905	5,249	15,557	8,495
Total	151,084	55,677	87,330	23,139	44,641	19,770

[1] Classification established Jan. 1, 1971.

Table 8.—U.S. imports for consumption of ferroalloys and ferroalloy metals

Alloy	1971			1972		
	Gross weight (short tons)	Content (short tons)	Value (thousands)	Gross weight (short tons)	Content (short tons)	Value (thousands)
Chromium metal	1,632	(1)	$2,966	1,894	(1)	$3,791
Ferrocerium and other cerium alloys	8	(1)	82	14	(1)	94
Ferrochromium—						
Containing 3% or more carbon	44,589	26,965	8,375	73,077	44,017	11,266
Containing less than 3% carbon	40,598	26,973	14,322	68,194	46,249	23,322
Ferromanganese—						
Containing less than 1% carbon	3,773	3,128	1,199	3,192	2,703	1,195
Containing over 1% and less than 4% carbon	30,200	24,760	7,274	55,066	44,889	13,125
Containing 4% or more carbon	208,805	161,372	23,919	290,281	227,125	35,526
Ferronickel	26,233	6,716	16,986	51,741	13,244	35,857
Ferrosilicon:						
8% to 60% silicon	11,975	3,729	2,310	14,525	4,824	3,054
60% to 80% silicon	12,418	r 8,891	r 3,419	24,920	18,182	5,714
80% to 90% silicon	74	63	21	--	--	--
Over 90% silicon	--	--	--	155	148	47
Ferrosilicon-chromium	772	(1)	207	8,427	(1)	1,846
Ferrosilicon-manganese (manganese content)	29,928	19,970	3,949	38,674	25,901	4,828
Ferrotitanium and ferrosilicon titanium	87	(1)	154	91	(1)	76
Ferrotungsten and ferrosilicon tungsten	19	15	98	508	407	2,169
Ferrovanadium	69	55	360	454	334	2,007
Ferrozirconium	1,126	(1)	477	2,604	(1)	1,159
Ferrophosphorous	916	(1)	45	308	(1)	15
Ferroalloys, n.e.c.	1,244	(1)	3,042	1,668	(1)	4,766
Manganese metal	2,870	(1)	1,203	4,121	(1)	1,675
Silicon metal (less than 99.7% silicon)	198	195	84	3,523	3,467	1,346
Total	417,534	XX	90,492	643,437	XX	152,878

r Revised. XX Not applicable.
[1] Not recorded.

WORLD REVIEW

Table 9 lists ferroalloy production in the world by country and furnace type for the years 1970 through 1972 from the most reliable data sources. Production increased moderately overall in 1972 compared to that of 1971 and 1970 as steel production increased rapidly to near-capacity levels late in the year. There were exceptions, such as Japan, where excessive inventories had accumulated during the first half of 1972.

The stagnation that occurred recently in the steel industry of the free world started earlier in the United States and spread rapidly throughout the free world. Underutilization of steel facilities implies an excess of ferroalloy capacity in those countries with established ferroalloy industries. Such conditions promote more international flow of those ferroalloy commodities in surplus with increasing exports to markets commanding higher prices such as the United States. As a result increasingly higher quantities of ferroalloys were imported into the United States during the interval 1970–72.

Belgium.—S.A. Application de la Chimie, de l'Electricité et des Métaux (SADACEM) completed installation of a 20 MVA enclosed ferroalloy furnace in 1972. This furnace, and a similar one installed in 1971, will be used principally to produce manganese alloys more efficiently and with proper control of emissions to the atmosphere.

Bolivia.—Empresa Nacional de Fundiciones (ENAF) engaged Skoda Export to conduct a feasibility study on a proposed ferroalloys plant near Lake Titicaca to produce 500 and 300 tons of ferrotungsten and ferrovanadium, respectively, per annum for the Andean Pact nations. Tungsten raw materials would be provided from tin operations in Bolivia whereas vanadium minerals would be imported.

Brazil.—Cia. de Ferro Ligas da Bahia, S.A. (the FERBASA group) has installed capacity to increase ferrochromium production from 12,000 tons in 1972 to an estimated 45,000 tons in 1973. Most of the additional output will be exported. Proven ore reserves do not justify further additional expansion but intense exploration was proceeding in adjoining promising geological formations.

Sibra Electro Siderúrgia in Bahia has contracted with Nippon Kokan KK to construct a $2.5 million ferroalloy facility in Brazil involving a 23 MVA furnace for high carbon ferromanganese and a 21 MVA furnace for silicon manganese. The anticipated output of 100,000 tons per year by 1975 is destined for export principally.

South Africa, Republic of.—The South African ferroalloys industry is engaged in major expansion programs aimed principally at the export market. African Metals Corporation (AMCOR) through its manganese subsidiary Metalloys Ltd. at Kookfontein, Transvaal, is installing two 42 MVA furnaces, both of which are to be in operation by the end of 1973. Overall the goal of AMCOR is to increase exports of high- and medium-carbon ferromanganese, ferrosilicon and high-carbon ferrochromium from 100,000 to 300,000 tons per year by 1974.[2]

The Ferrometals Ltd. division of African Metals Corporation at Witbank has completed a 35 MVA silicon furnace with an estimated capacity of 50,000 tons per year with the expectation that its production will be principally for export. A second furnace of 48 MVA devoted to high-carbon ferrochromium with an annual capacity of 125,000 tons, of which 80% will be available for export, is planned for completion in 1973.

Because of the increased adoption of post-melting furnace treatments, higher percentages of the lower cost high-carbon ferrochromium types can be utilized in producing stainless alloys. Through benefication the lower grade Transvaal ores can be smelted directly and compete for a major percentage of the ferrochromium business.

African Oxygen (subsidiary of British Oxygen), Aluminum Company of Canada, and Foote Mineral Co. have formed Silicon Smelters Pty. Ltd. to construct a silicon metal electric furnace reduction plant of 30,000-ton-per-year capacity at Pietersburg in the Transvaal. Most of the product will be marketed for the alloying of aluminum. Delta Manganese Pty. is constructing a $21 million electrolytic manganese facility in the Transvaal with initial production in

---

[2] Coal, Gold, and Base Minerals of Southern Africa, February 1972, pp. 19–23.

Table 9.—Ferroalloys: World production by country [1] and furnace type

(Thousand short tons)

Country	1970	1971	1972 p
BLAST FURNACE [2]			
Europe:			
Belgium	3	--	--
Denmark	10	8	7
France	536	490	495
Germany, West [3] [4]	r 475	373	347
Hungary	7	8	e 8
Italy	24	20	34
Poland	151	158	e 150
Portugal	8	8	10
U.S.S.R.	1,239	1,110	e 1,146
United Kingdom	183	170	168
Africa:			
South Africa, Republic of	51	72	e 81
Asia:			
Korea, Republic of [5]	15	16	18
ELECTRIC FURNACE [6]			
North America:			
Canada [2]	210	213	251
Mexico	83	74	e 77
United States [2]	2,595	2,331	2,527
South America:			
Argentina	35	31	e 33
Brazil	r 104	138	150
Chile	13	14	e 14
Europe:			
Austria	6	6	6
Bulgaria	55	47	e 55
Czechoslovakia	115	134	130
Finland	36	39	27
France	374	386	e 386
Germany, West	297	258	240
Hungary	11	11	e 11
Italy	193	192	188
Norway	r 639	834	704
Poland	131	147	e 160
Romania	1	--	--
Spain	123	144	193
Sweden	257	260	e 267
Switzerland	e 10	25	e 23
Yugoslavia	112	128	144
Africa:			
South Africa, Republic of	389	420	e 460
Asia:			
India	236	235	222
Japan	r 1,836	2,083	1,921
Taiwan	6	8	8
Turkey e	10	10	10
Oceania:			
Australia [2] [7]	87	e 86	e 88
Total	r 10,666	10,687	10,759

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, Colombia, Greece, Norway, Peru, Venezuela, 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 ferroalloy production by Australia, Canada, and United States included under electric furnace output; that of Czechoslovakia is included under pig iron.

[3] Blast furnace ferromanganese and spiegeleisen only; other blast furnace ferroalloys are included with pig iron production in the iron and steel chapter.

[4] Revised to include blast furnace ferrosilicon previously reported with pig iron.

[5] Includes electric furnace ferroalloys if any are produced.

[6] 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.

[7] Year ended November 30 of year stated.

1974 and capacity operation of 28,000 annual tons in 1975. Foote Mineral Co. will be the exclusive sales agent in the United States and Mexico.

Transvaal Alloys has initiated development of a 4,000-ton-per-day mine and concentrator to exploit the Busveld Development vanadium deposit near Uitvlugt in the Transvaal. Production of 1,500 tons per year of vanadium pentoxide is planned at a plant site at Staffberg with initial shipments in 1974.

Highveld Steel and Vanadium Corp. at Witbank is expanding steel and iron-smelting capacity by 25% and thereby increasing its vanadium slag output proportionately. The additional slag production will be for export.

Spain.—Hydro Nitro Española brought into production in May 1972 a 45 MW refined ferromanganese furnace at Huesca. A second furnace was started up by yearend. Annual export of 30,000 tons of ferromanganese was projected until new steel capacity in Spain is brought onstream in 1975–76.

United Kingdom.—British Steel Corp. completed a $6 million modernization program on the No. 5 blast furnace at the South Teeside Works which, with the adjoining No. 4 blast furnace, provides capacity of 200,000 tons per year of ferromanganese. The combined facility is capable of supplying the total high-carbon ferromanganese requirements projected for the United Kingdom steel industry in the foreseeable future.

TECHNOLOGY

The secondary refining or post-furnace treatment techniques involving oxygen-argon or oxygen injection in separate closed vessels (A.O.D. or V.O.D. processes) have been adopted rapidly by many of the larger stainless steel melting shops in the United States, Japan, and Western Europe. The processes permit higher production rates from melting furnaces and greater percentage utilization of high-carbon ferrochromium, effecting savings estimated conservatively of $20 per ton.

Foundries producing ductile iron are anxious to reduce smoke and fume from the ladle reactions associated with magnesium additions. To meet this need, International Nickel Co., Inc., introduced two alloys, INCOMAG 3 and 4, with controlled density and 4% to 5% magnesium which reduce smoke appreciably, and Ferroalloys Division of Union Carbide Corp. introduced REMAG, a cerium-magnesium-45% silicon alloy which reduces smoke similarly.

Calcium, in conjunction with aluminum and silicon, in the deoxidation of gear steels results in lower hardness inclusions than aluminum-silicon deoxidation. Complex calcium-aluminate inclusions form instead of the extremely hard alumina inclusions; the result is considerable improvement in cutting edge life of the tool steel cutters utilized in machining automotive gears and pinions. Improvements in number of pieces produced per rougher tool grind have ranged from 60% to 100% in applications on subsequently heat-treated high-performance carbon and alloy steel parts.

Fluorspar and Cryolite

By H. B. Wood [1]

FLUORSPAR

World supply of fluorspar improved greatly during 1972. At yearend U.S. consumers found no shortage of either acid-grade (acid-spar) or metallurgical-grade (met-spar) fluorspar. In fact, additional supplies were readily available from Mexico and the Republic of South Africa.

Although prices in 1972 reached an all-time high, some new 1973 contracts showed lower prices. However, no significant reduction in price is anticipated in the near future. Devaluation of the dollar and adjustments in foreign exchange rates also tended to cause higher prices.

During the last 3 to 4 years, accelerated exploration has been inspired by rising prices. As a result many new discoveries or mine expansions were made in Mexico, Thailand, the Republic of South Africa, and even in the United States. New fluorspar deposits started to come into production by yearend.

Overall consumption of fluorspar in the United States showed little change compared with 1971. In 1972 the United States consumed 1,352,000 short tons or about 26% of the estimated world supply while only producing 250,000 tons or about 5% of the estimated world supply. In other words, only 18% of U.S. consumption was indigenously produced. Demand for fluorspar in the steel, chemical, and aluminum industries continued strong. Combined, these industries consumed over 90% of the U.S. total. The rest was consumed by the ceramic, glass, cement, nuclear reactor, and oil industries. Notable growth in consumption is anticipated in the uranium industry to produce uranium tetrafluoride, and in the oil industry as a catalyst. Less acid-spar was used by aluminum companies which recycled more waste fluoride compounds. In addition, fluorine from fluosilicic acid (H_2SiF_6), a byproduct recovered during phosphoric acid manufacture, was processed to make cryolite and aluminum fluoride for use in primary aluminum production. In 1972 this new supply was equivalent to the amount of fluorine obtainable from about 55,000 tons of acid-spar.

Legislation and Government Programs.—As of December 31, 1972, Government stockpiles included 921,826 tons of acid-spar, with 350,000 tons of acid-spar credited as 438,000 tons of met-spar towards the met-spar objective. Government stockpiles also included 411,788 tons of met-spar. The percentage depletion allowance rates established in 1969 remained the same; domestic 22% and foreign 14%.

The Office of Minerals Exploration, U.S. Geological Survey, in September 1972 executed a fluorspar exploration contract with Hicks Dome Account of New York City. Exploration started in 1972 on the Hicks Dome prospect in Hardin County, Ill.

During 1972 no action was taken on Congressional Bills H.R. 11696, H.R. 11735, H.R. 11767, and H.R. 11976, which in 1971 had been introduced into the U.S. Congress to suspend the current import duty on fluorspar until January 1, 1974.

DOMESTIC PRODUCTION

Total U.S. production of fluorspar decreased 8% from 272,000 tons in 1971 to 250,000 tons in 1972. A softening in the demand for acid-grade fluorspar during the second half of 1972 probably caused the closing down of Minerva Oil Co.'s old Crystal Mill at Cave-In-Rock, Ill., and the reduced production from the Calvert City Chemical Co.'s plant near Mexico, Ky.

The Illinois fluorspar mining district, consisting of Hardin and Pope Counties in southern Illinois, continued as the principal source of domestic fluorspar in 1972

[1] Geologist, Division of Nonmetallic Minerals.

and provided 53% of total U.S. shipments for the year. The lead and zinc byproducts of the Illinois fluorspar mines were also important to the operations. Other producing States were Colorado, Montana, Nevada, Texas, Utah, Arizona, New Mexico, and Kentucky where byproducts were not significant. By producing at about the same rate as a year earlier, Colorado maintained its position as the second largest fluorspar-producing State in the United States.

In 1972, the mining industry operated at normal levels. The acid-spar market softened in the last quarter, but the metspar-market remained strong. New mines opened in Illinois, Texas, and Arizona, but no shipments were reported from two mines in Arizona, three mines in Utah, or from one mine each in Nevada, Idaho, and Kentucky. In 1972, 12 companies operated 24 mines in Arizona, Colorado, Illinois, Kentucky, Montana, New Mexico, Nevada, Texas, and Utah. Fluorspar ores were concentrated in 15 heavy-media and/or flotation plants. Employment totaled approximately 1,200 men. Fluorspar shipments were valued at over $17 million.

Table 1.—Salient fluorspar statistics

	1968	1969	1970	1971	1972
United States:					
Production:					
Crude:					
Mine production____short tons__	749,219	533,030	627,212	815,046	710,668
Material beneficiated____do____	765,531	520,084	698,232	758,169	771,411
Material recovered______do____	237,000	160,000	252,128	247,250	245,047
Finished (shipments)_________do____	252,411	182,567	269,221	272,071	250,347
Value_____________thousands__	$11,656	$8,411	$13,923	$17,263	$17,315
Exports__________________short tons__	12,614	3,605	14,952	12,491	2,764
Value_________________thousands__	$496	$213	$1,145	$525	$184
Imports for consumption____short tons__	1,050,107	1,149,546	1,092,318	1,072,405	1,181,533
Value________________thousands__	$28,699	$32,818	$32,758	$34,530	$47,851
Consumption (reported)_____short tons__	1,243,414	1,356,624	1,372,404	1,344,742	1,352,149
Stocks Dec. 31:					
Domestic mines:					
Crude_________________do____	97,522	82,177	51,471	165,610	111,565
Finished________________do____	12,557	9,751	12,370	28,259	15,294
Consumer plants____________do____	323,121	290,470	419,746	436,759	377,942
World: Production_________________do____	4,006,971	4,285,010	4,620,469	5,243,644	5,150,291

Table 2.—Shipments of finished fluorspar, by State

State	1971			1972		
	Quantity (short tons)	Value		Quantity (short tons)	Value	
		Total (thousands)	Average per ton		Total (thousands)	Average per ton
Illinois__________________	138,051	$9,883	$71.59	132,405	$9,961	$75.23
Utah___________________	10,947	341	31.15	2,977	84	28.22
Other States [1]___________	123,073	7,039	57.19	114,965	7,270	63.24
Total and average__	272,071	17,263	63.45	250,347	17,315	69.16

[1] Includes Idaho, 1971; Arizona, Colorado, Kentucky, Montana, Nevada, New Mexico, and Texas, 1971–72.

Table 3.—Shipments and mine stocks of finished fluorspar by grade, in the United States

Grade	1971				1972			
	Shipments			Stocks [1] (short tons)	Shipments			Stocks [1] (short tons)
	Quantity (short tons)	Value (thousands)	Value per ton		Quantity (short tons)	Value (thousands)	Value per ton	
Acid_______________________	106,263	$7,604	$71.56	3,907	133,348	$8,443	$63.32	9,867
Metallurgical_______________	165,808	9,659	58.25	24,352	116,999	8,872	75.83	5,427
Total and average______	272,071	17,263	63.45	28,259	250,347	17,315	69.16	15,294

[1] Mine stocks as of Dec. 31.

Table 4.—Fluorspar shipped from mines in the United States, by grade and use

Grade and use	1971				1972			
	Quantity		Value		Quantity		Value	
	Short tons	% of total	Total (thousands)	Average per ton	Short tons	% of total	Total (thousands)	Average per ton
Ground and flotation concentrates:								
Hydrofluoric acid	106,263	52.4	$7,604	$71.56	111,786	56.7	$8,385	$75.01
Glass	20,712	10.2	1,540	74.35	22,375	11.4	1,751	78.26
Ceramic and enamel	14,106	7.0	561	39.77	10,625	5.4	491	46.21
Nonferrous	1,333	.7	103	77.27	715	.4	57	79.72
Ferrous [1]	56,733	27.9	3,221	56.77	49,619	25.2	3,638	73.32
Miscellaneous	[1] 3,561	1.8	[1] 246	69.08	1,877	.9	151	80.45
Total and average	202,708	100.0	[2] 13,277	65.50	196,997	100.0	14,473	73.47
Fluxing gravel and foundry lumps:								
Ferrous	67,480	97.3	3,842	56.94	52,672	98.7	2,793	53.03
Miscellaneous	1,883	2.7	143	75.94	678	1.3	49	72.27
Total and average	69,363	100.0	[2] 3,986	57.47	53,350	100.0	2,842	53.27

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

In Alaska, Lost River Mining Co. Ltd. continued feasibility studies and some metallurgical research. However, there were no indications that mine and surface operations had gotten underway.

In Arizona, Tonto Mining and Milling Co., Inc. with operations northeast of Phoenix, continued working three small mines and a flotation plant, which has a reported annual capacity of 30,000 tons of acid-spar. The acid-spar product was shipped to Allied Chemical Co.'s HF plant at Pittsburgh, Calif.

In Colorado, the Ozark-Mahoning Co. in the Northgate district, and the Allied Chemical Co. at Jamestown, continued to be the principal producers of fluorspar ore.

In Idaho, N.L. Industries Inc. staked mill-site claims and performed exploratory drilling and drifting to develop the Bayhorse fluorspar prospect located southwest of Challis. A major effort was expended in mapping the area and gathering information for an environmental impact study. Seaforth Minerals and Ore Co. carried out more extensive drilling to learn if there was enough minable ore to justify building a froth flotation plant near its Meyers Cove fluorspar deposit. Ozark-Mahoning performed exploration drilling on its Chalspar group of unpatented claims on Garden Creek west of Challis.

In Illinois, Ozark-Mahoning and Minerva Oil Co. were operating at near full capacity. Ozark-Mahoning started its Knight mine shaft, produced regularly from the NEL Davis Nos. 4 and 7 shafts and from the North Green and Bonnet mines, and operated the Rosiclare mill around the clock. At the Minerva No. 1 flotation plant near Cave-in-Rock, Minerva Oil Co. processed ore from mines in Illinois and Kentucky. In October Minerva closed down the froth flotation circuit at its Crystal Mill in Illinois, and thereafter intermittently operated only the heavy-media circuit.

In Kentucky, Cerro Corp. as the operator for the joint venture of Cerro and three associates started sinking a shaft on the Babb-Barnes tract near Mexico. It is reported that this shaft and the related flotation plant will be completed near the close of 1973. Calvert City Chemical Co. operated a modernized flotation plant in Mexico, on ores from the Shouse and Babb-Guill mines.

In Montana, Roberts Mining Co. continued to ship from stockpiles of gravel met-spar at Darby. Management reported that production has not been resumed at the open pit mine because of Montana's environmental regulations.

In New Mexico, Midwest Oil Co. and Perry-Knox and Kaufman Inc. obtained leases on the Turtle Dove claims within the E. T. Chavez Ranch near Truth-or-Consequences. An extensive exploration program was started late in 1972. The mine and small flotation plant of Win Industries, west of Truth-or-Consequences, went on-stream the first part of 1972. However, soon after opening a flash flood washed out the road and part of the stockpiled fluorspar; operations were never resumed during 1972.

In Oregon during the fall of 1972, Aluminum Company of America (Alcoa) acknowledged that a large number of claims had been staked on a fluorspar prospect in the Crooked River area 5 miles west of Rome, Oreg. This prospect was described in a U.S. Geological Survey publication.[2] Fluorspar assays up to 20% CaF_2 were reported, but the average is about 8% CaF_2. A resource of 12 million tons was estimated in the report. Alcoa personnel do not consider this occurrence to represent an economically viable deposit, because of metallurgical and processing problems, but more exploration and research will be done. To date, no known laboratory tests have been successful in extracting the micron-size fluorspar grains from the matrix of zeolites and silicates disseminated in fine-grained zeolite tuffaceous siltstone.

In Tennessee, Amoco Minerals Co. completed drilling 26 holes in 1972 on a fluorspar prospect in the Sweetwater barite district. A breccia zone containing a reported 10 million tons of 15% CaF_2 was drilled out. No additional activity has been reported at this paramarginal deposit, ever since Amoco completed its exploration program.

In Texas, D. & F. Minerals Co. mined fluorspar from the La Mina Paisano mine in the Christmas Mountains, and shipped met-spar to Delhi Foundry Sand Co's buying station at Marathon for transhipment to Kaiser Steel Co.'s steel smelter at Fontana, Calif.

In Utah, only the Wilden Fluorspar Co. shipped some met-spar. Three previously active mines owned by other companies did not produce.

The manufacture of fluorspar briquets or pellets continued at the six known plants in the United States. Fluorspar concentrates of near acid-spar grade were used by Ozark-Mahoning, Cometco Corp., and Mercier Corp. to make briquets of variable CaF_2 content. The plants at Brownsville, Tex., reportedly used flotation concentrates and high-grade fines from met-spar washing plants.

CONSUMPTION AND USES

Fluorspar containing different percentages of CaF_2 is essential to the steel, glass, ceramic, and cement industries. Fluorine, as hydrofluoric acid (HF), is essential to the chemical, aluminum, oil, and nuclear reactor industries. The consumption trends of fluorspar depend directly on the growth of the previously mentioned industries. Within the United States, the steel industry consumed about 43% of the total fluorspar, the chemical industry about 36%, the aluminum industry about 14%, and other industries about 7%.

[2] Sheppard, R. A. and A. J. Gude. Authigenic Fluorite in Pliocene Lacustrene Rocks Near Rome, Malheur County, Oreg. U.S. Geol. Survey, Prof. Paper 650-D, 1970, pp. D69-D74.

Table 5.—U.S. consumption of fluorspar by end use and by grade in 1972

(Short tons)

End use or product	Containing more than 97% calcium fluoride	Containing not more than 97% calcium fluoride	Total
Hydrofluoric acid	717,785	(1)	717,785
Glass and fiberglas	5,926	13,824	19,750
Enamel	456	2,012	2,468
Welding rod coatings	680	(2)	680
Primary aluminum	978	--	978
Primary magnesium	1,000	--	1,000
Other nonferrous metals	553	438	991
Iron and steel castings	407	23,975	24,382
Open-hearth furnaces	--	68,217	68,217
Basic oxygen furnaces	--	387,162	387,162
Electric furnaces	2,811	105,565	108,376
Other uses or products [3]	420	19,940	20,360
Total	731,016	621,133	1,352,149
Stocks Dec. 31	95,251	282,691	377,942

[1] Small tonnages included under fluorspar containing more than 97% calcium fluoride.
[2] Included with "Other uses or products."
[3] Includes fluorspar used to make ferroalloys and other furnace products.

Table 6.—Fluorspar (domestic and foreign) consumed in the United States by State

(Short tons)

State	1972
Alabama, Kentucky, Tennessee	79,876
Arizona, Colorado, Utah	24,351
Arkansas, Kansas, Louisiana, Missouri	228,590
California	37,599
Connecticut, Massachusetts, New York, Rhode Island	33,273
Illinois	67,428
Indiana	75,431
Iowa, Minnesota, Nebraska, Wisconsin	30,020
Michigan	60,112
New Jersey	66,089
Ohio	160,497
Oregon, Washington	1,087
Pennsylvania	161,887
Texas	246,732
West Virginia	53,747
Other States [1]	25,430
Total	1,352,149

[1] Includes Florida, Georgia, Maryland, North Carolina, Virginia, Delaware, Mississippi, and Oklahoma

Fluorspar consumption by the steel industry is basically affected by business fluctuations and changes in fluorspar requirements per ton of steel. World steel production rose approximately 8% from 1971 to 1972, and U.S. production rose approximately 10%. Consumption of fluorspar as a steel flux increased about 2.7%, whereas consumption of other fluxes, exclusive of limestone and fluorspar mixes, increased about 37%. However, the use of substitute fluxes has not been widely accepted by steel producers. Consumption of fluorspar per ton of steel dropped from about 9 pounds in 1971 to about 8 pounds in 1972. This reduced consumption per ton was probably caused to some extent by use of substitutes, but mostly to more efficient use of fluorspar.

Quality met-spar is needed when smelting high-carbon steel. Other fluxes such as red mud, manganese slag, olivinite, ilmenite, lime-iron oxide mixes, and colemanite have been tested in combination with met-spar or as a complete substitute for use in fluxing a select group of low-carbon steels. Generally, these substitute fluxes were slower reacting, required more pounds per ton of steel, were not as effective purifiers, and were not available in sufficient quantity or at reasonable prices.

Although long-term demand for steel in the United States is anticipated to grow at a rate of 2.5% annually, steel production in 1973 may reach 145 million tons, a 9% increase over that of 1972. For 1972, the American Iron and Steel Institute (AISI) reported that about 531,000 tons of fluorspar was used; this compares with 588,000 tons shown in table 5, which is the figure compiled from Federal Bureau of Mines canvasses. If the 1973 steel production estimate of 145 million tons is achieved and the U.S. consumption of fluorspar continues at the rate of 8 pounds per ton, consumption will be about the same as in 1972.

The fluorspar consumption rate by U.S. Steel's "Q-BOP" (basic oxygen furnace) process has not been reported publicly, and cannot be accurately determined until a new plant is brought into production. In the "Q-BOP" operation, finely-ground fluorspar, along with powdered lime, is blown in from the bottom, and scrubbing devices are installed to recover any discharge gases and particulates. Reportedly, the "Q-BOP" smelter is designed to replace open-hearth furnaces as they are phased out.

Most of the acid-grade fluorspar containing more than 97% CaF_2 is used to make HF or hydrogen fluoride (table 5). HF has many uses. In the chemical industry many inorganic and organic compounds are made from HF, such as aluminum fluoride, cryolite, sodium fluosilicate, potassium fluosilicate, sodium fluoride, ammonium fluoride, and a long list of fluorocarbons. It is also commonly used in glass etching, stainless steel pickling, petroleum alkylation, in making uranium tetrafluoride, and in water fluoridation. Inorganic fluorides are used mostly as electrolyte fluxes in the production of aluminum. Fluorocarbons are used commonly as refrigerants, aerosol propellants, plastics, and foam applicators.

World production of HF is increasing. West European countries have the largest number of HF plants in operation in the free world. In addition, there are two working plants in Canada; three in Mexico, with another being built at Matamoros, Tamaulipas, Mexico; two in Japan, with another being built; and one in Australia (still in process of being built).

U.S. consumption of HF has been estimated by W. R. Jones of E. I. du Pont de Nemours & Co. Inc. at 365,000 tons in 1972 and 500,000 tons by 1977. In explaining U.S. demand, Mr. Jones stated, "The fluorocarbon and aluminum industries consumed 80% of the HF now produced in the U.S. and major HF growth will continue in those industries. Use in petroleum alkylation and uranium processing will grow the fastest in the remainder of the 70's, but still represent less than 10% of the total HF consumption for the foreseeable future. Overall a 6.5% growth rate is projected for HF over the next 5 years." [3]

Consumption of HF (70% aqueous) in 1972

End use	Quantity (short tons)	% of total
Fluorocarbons	145,000	40
Aluminum	145,000	40
Petroleum alkylation	15,000	4
Uranium	7,500	2
Stainless steel pickling	12,500	3
Fluoride salts	12,500	3
Miscellaneous	27,500	8
Total	365,000	100

Oversupply of fluorocarbons was expected to persist until 1976 owing to overcapacity construction of fluorocarbon plants, and to substitution of cheaper hydrocarbon propellants. According to H. Lee Noble of Allied Chemical Corp., 1972 U.S. fluorocarbon demand was about 420,000 tons and capacity was 610,000 tons; incremental expansions by 1976 will raise U.S. capacity to 675,000 tons, while anticipated demand will only increase to about 580,000 tons. Sales of fluorocarbons for propellants was anticipated to grow 6% to 7% per year through 1978, and to represent 48% of the fluorocarbon market.

Noble estimated that from 1972 to 1978, the refrigeration and air-conditioning market was expected to continue its growth of 7% to 8% per year and to comprise 30% of the fluorocarbon market, up from the former 28%.[4]

E. I. du Pont reportedly plans to build the world's largest fluorocarbon facility at Corpus Christi, Tex., with an initial annual capacity of 250,000 tons of fluorine chemical intermediates,[5] such as Freon and other fluorocarbons used for refrigeration, air conditioning, aerosol propellants, solvents, dry cleaning, fire extinguishers, and food processing. No estimate was given as to the tonnage of acid-spar or HF that would be required to make the 250,000 tons of fluorocarbons. The construction of this plant and the expansion of others verify the accelerated growth in fluorspar consumption as predicted by Noble and Jones.[6]

Consumption of acid-spar by the aluminum industry can no longer be directly related to growth in the industry because of many recent operating changes. U.S. aluminum ingot production for 1972 increased 5% over the 1971 production, whereas world output gained only 4%.[7] Acid-spar consumption in electrolytic potlines did not match this growth rate in 1972, nor is it expected to for 1973. With the advent of emission controls by Federal and State environmental protection agencies, and the high 1972 prices for acid-spar, aluminum companies successfully started salvaging emitted fluorine-bearing particulates and gasses. The emission control efficiency ranged from zero at plants without controls to about 94% at plants with control systems. The average was about 73%. About half (46%) of the fluorine emitted was in the gaseous state, and the remainder in the solid state. In those plants having efficient emission control, the companies salvaged and recycled the fluorine-bearing particulates by feeding them directly into the reduction cell. By 1972, the recycled, salvaged fluoride compounds from the potlinings and from the emitted particulates were estimated to have

[3] Chemical Marketing Reporter. HF Consumption at 500,000 Tons Foreseen in 1977. V. 201, No. 19, May 8, 1972, p. 3.

[4] Chemical Marketing Reporter. Fluorocarbon Makers Can Expect Over-Supply to Persist Until 1976. V. 201, No. 20, May 15, 1972, p. 7.

[5] Chemical Marketing Reporter. Fluorocarbon Facility to be World's Largest. V. 201, No. 13, Mar. 27, 1972, pp. 5 and 26.

[6] Work cited in footnotes 3 and 4.

[7] American Metal Market. Primary Aluminum Demand Rising: Irving Lipkowitz of Reynolds Metals Co., Dec. 15, 1972, p. 17.

reduced by about 11% the consumption of primary fluorine from 140 pounds of CaF_2 to 125 pounds.

In the absence of any fixed consumption rate, it was estimated that 125 pounds of acid-spar was required per ton of aluminum produced. Except for a small percentage of acid-spar that is added to the electrolytic potline as a flux, the major tonnage of fluorine salt fluxes, Na_3AlF_6 and AlF_3, were made from HF. In 1972, 4,112,000 tons of aluminum were produced in the United States; and theoretically, about 257,000 tons of acid-spar were used. However, in 1972 about 39,000 tons of H_2SiF_6, a byproduct of the phosphate fertilizer industry, was used to make Na_3AlF_6 and AlF_3. This new substitute source thus reduced by 55,000 tons the primary demand of acid-spar from 257,000 tons to about 202,000 tons or 15% of U.S. consumption.

Fluorine as HF is used in the nuclear reactor industry to produce stable uranium tetrafluoride (UF_4) by reacting UO_2 with anhydrous HF. Subsequently, when needed, fluorine gas is added to the UF_4 to make unstable uranium hexafluoride (UF_6) before feeding into the diffusion plant for separation of U-235 and U-238. The spent UF_6 (minus U-235) is stored in pressurized metal tanks.

Theoretically, there is almost an equal amount of fluorine in 1 ton of 97% CaF_2 as there is in 1 ton of UF_6, but in processing through the stages from CaF_2 to HF and to UF_4 or UF_6 some fluorine is lost. It is reported that about 1.5 to 1.66 tons of acid-spar were required to produce 1.0 ton of UF_6. The 1972 fluorine requirement for domestic nuclear power reactors, as reported by the U.S. Atomic Energy Commission (AEC) was estimated at 3,000 tons of fluorine, which is equivalent to at least 6,000 tons of acid-spar. The demand is conservatively anticipated to increase 2 times in the next 5 years and accelerate thereafter. Of the UF_6 fed to the gaseous diffusion plant about 15% was withdrawn in the enriched uranium product. The remainder was left in the waste stream and probably stored as UF_6. There is no known commercial recovery of fluorine from UF_6, but the AEC has recovered some for its own use.

If all the UF_6 in the waste stream could be converted to UF_4 and then salvaged as anhydrous HF for reuse, about 20% to 25% less primary fluorine would be required. No information was available on the amount of UF_6 being produced at two known commercial plants or that is in stocks of fluorine products held by these companies. No information is available on the UF_4 or UF_6 stocks held by the AEC. The estimated amount of CaF_2 used to make HF and then distributed to making UF_6 and UF_4 ranges from 2% to 4% of the total CaF_2 used to make HF.

The consumption of fluorine as a liquid fuel in the space program has been mentioned in the literature. In 1971 and 1972 all testing for use of fluorine in rockets was performed in a closed circuit permitting reuse of the fluorine. The use of fluorine in space booster rockets or burns for handling the shuttle platform is being considered, but if it is used, the consumption would be minor.

STOCKS

Producers stocks of finished fluorspar were reduced 46% and consumers stocks were reduced 13%, which is another indication that neither the producers nor consumers were worried about inadequate supplies. More than necessary stockpiles of fluorspar were reported to exist in Mexico, Thailand, Spain, and the Republic of South Africa.

PRICES

Prices of standard finished fluorspar material did not increase significantly from 1971 to 1972. According to the U.S. Bureau of Mines canvass and to verbal information, the spread between the quoted low and high prices was greater in 1972, ranging from \$55 to \$87.50 per ton for a acid-spar, from \$42 to \$57 for gravel spar, and from \$65 to \$95 for fluorspar pellets of variable CaF_2 content. Some spot purchases for quality acid-spar were about \$66.50 per ton delivered to the consumer.

Fluorspar prices in foreign countries varied greatly. In Europe they were generally higher, 18% to 34%, due primarily to the decrease in value of the U.S. dollar on the European exchange market. As shown in table 9 the value of acid-grade fluorspar f.o.b. foreign port ranged from \$55 to \$87 per ton in Italy, and from \$62 to \$69 in Spain. In Mexico, where U.S. prices are established, acid-spar values increased 22% and averaged about $42 per ton f.o.b. foreign port, and met-spar values increased about 35% and averaged about $28 per ton.

Met-spar prices in Thailand, the second largest producer in the world, dropped in the last quarter of 1972 and were quoted at yearend at $35 to +$38 per ton f.o.b. Bangkok.

Because over 53% (table 5) of U.S. consumption of fluorspar is used to make HF, the trend of the HF market is important. In 1972 the price of 70% aqueous HF ranged from $400 to $560 per ton.

Table 7.—U.S. prices of fluorspar

	1971	1972 [1]
Domestic f.o.b. Illinois-Kentucky:		
Metallurgical-grade, 72½% effective CaF_2	NA	NA
Pellets, 70% effective CaF_2	$68.50	$68.50
Acid-grade concentrates, dry basis, 97% CaF_2:		
Carloads	70.50–85.00	78.50–87.00
Less than carloads	78.50–85.00	78.50–87.00
Bags, extra	6.00	6.00
Pellets, 90% effective CaF_2	76.50	76.50
Ceramic-grade, 95% to 96% CaF_2	76.50–80.00	76.50–82.00
European: f.o.b. Wilmington/Philadelphia:		
Acid-grade, duty paid, dry basis	72.50–73.50	81.00–82.00
Mexican:		
Metallurgical-grade, 70% effective CaF_2:		
Border, all rail, f.o.b. cars	48.33–50.33	48.50
Tampico, Mex., f.o.b. vessel	47.33–49.33	50.00
Acid-grade, more than 97% effective CaF_2:		
Eagle Pass, Tex., bulk	62.67	62.00–67.00

NA Not available.

[1] Prices reported in the Engineering and Mining Journal do not reflect the soft market for flourspar that developed during the last quarter of 1972.

Source: December issues of Engineering and Mining Journal, 1971 and 1972.

FOREIGN TRADE

Exports continued to be of minor importance in 1972; about 2,300 tons out of a total of 2,700 tons were shipped to Canada. On the other hand, imports of fluorspar were nearly 711,000 tons, an increase of 23% over the 1971 level. As in 1971, two-thirds of the fluorspar imports came from Mexico and the rest mainly from Spain and Italy.

Table 8.—U.S. exports of fluorspar

Country	1970		1971		1972	
	Quantity (short tons)	Value	Quantity (short tons)	Value	Quantity (short tons)	Value
Argentina	(1)	$1,265	2	$5,210	95	$3,420
Brazil	--	--	--	--	24	7,591
Canada	2,670	137,533	12,033	484,890	2,324	125,447
Chile	17	1,470	--	--	5	601
Colombia	17	1,650	40	4,843	24	3,184
France	16	1,315	1	1,074	4	720
Germany, West	279	13,046	220	15,620	138	15,898
India	55	7,426	--	--	--	--
Japan	11,720	960,896	--	--	18	660
Mexico	25	764	--	--	18	2,124
Panamá	38	2,812	--	--	--	--
South Africa, Republic of	--	--	--	--	75	7,658
Switzerland	28	2,410	39	1,419	--	--
United Kingdom	50	1,792	63	2,274	5	10,989
Venezuela	29	883	13	1,700	19	3,206
Yugoslavia	--	--	72	7,003	--	--
Other	8	11,599	8	1,456	15	2,122
Total	14,952	1,144,861	12,491	525,489	2,764	183,620

[1] Less than ½ unit.

Table 9.—U.S. imports for consumption of fluorspar, by country and customs district

Country and customs district	1971 Quantity (short tons)	1971 Value (thousands)	1972 Quantity (short tons)	1972 Value (thousands)
CONTAINING MORE THAN 97% CALCIUM FLUORIDE				
Canada:				
Laredo	74	$3	--	--
Ogdensburg	24	1	--	--
Total	98	4	--	--
France: New Orleans	4,489	267	--	--
Germany, West: Philadelphia	5,341	288	5,202	$295
Italy:				
Cleveland	--	--	10,127	888
Detroit	4,989	200	7,726	429
Galveston	27,223	1,441	42,176	2,453
New Orleans	33,518	1,843	14,212	782
Philadelphia	5,164	207	--	--
Total	70,894	3,691	74,241	4,552
Mexico:				
El Paso	69,026	1,727	63,925	1,635
Houston	751	30	758	31
Laredo	320,606	11,231	321,542	13,283
New Orleans	13,936	645	42,788	2,543
Nogales	25,172	900	23,423	839
Philadelphia	3,801	116	18,234	1,142
San Diego	59	3	234	13
San Francisco	263	9	--	--
Total	433,614	14,661	470,904	19,486
Mozambique: New Orleans	--	--	5,256	247
South Africa, Republic of:				
Baltimore	--	--	1,069	41
Galveston	6,501	246	5,032	199
Philadelphia	2,816	100	8,318	305
Total	9,317	346	14,419	545
Spain:				
Cleveland	24,800	1,334	25,701	1,770
Detroit	18,304	782	31,433	1,950
Galveston	--	--	3,373	232
New Orleans	4,536	196	4,435	279
Philadelphia	68,918	3,448	69,898	4,702
Total	116,558	5,760	134,840	8,933
Switzerland: Cleveland	12,367	668	--	--
Tunisia: New Orleans	--	--	6,002	367
Grand total	652,678	25,685	710,864	34,425
CONTAINING NOT MORE THAN 97% CALCIUM FLUORIDE				
Colombia: Philadelphia	--	--	2,642	97
Mexico:				
Baltimore	19,630	827	11,657	494
Buffalo	19,143	768	18,758	522
Chicago	--	--	1,430	69
Cleveland	26,732	1,154	27,461	1,393
Detroit	82,264	1,118	16,643	781
El Paso	36,490	709	30,501	718
Houston	--	--	158	6
Laredo	211,194	3,304	300,692	6,825
New Orleans	11,044	411	25,032	1,093
Nogales	64	2	214	7
Philadelphia	10,089	436	20,558	866
St. Albans	--	--	227	8
Total	416,650	8,729	453,331	12,782
South Africa, Republic of:				
Buffalo	--	--	5,311	220
New Orleans	1,120	46	9,385	327
New York City	271	18	--	--
Philadelphia	1,686	52	--	--
Total	3,077	116	14,696	547
Grand total	419,727	8,845	470,669	13,426

Table 10.—U.S. imports of 70% hydrofluoric acid

Country	1971 Quantity (short tons)	1971 Value	1972 Quantity (short tons)	1972 Value
Canada	19,601	$5,901,369	12,946	$4,510,698
Germany, West	(1)	574	(1)	692
Japan	50	8,730	--	--
Mexico	1,698	586,704	1,225	404,203
United Kingdom	(1)	888	--	--
Total	21,349	6,498,265	14,171	4,915,593

1 Less than ½ unit.

WORLD REVIEW

Australia.—Production of fluorspar in 1972 was limited to byproduct extraction and some test shipments. Many fluorspar deposits have been discovered, mostly in southern Australia. Some of those delinated by drilling were reported to be of the million-ton size, but either the reports were false or the development work required has prevented these discoveries from getting into production. Rising domestic demand for both met-spar and acid-spar is expected to stimulate Australian production in the near future.

Fluorspar consumption by the Australian steel and aluminum industries totaled about 37,000 tons in 1970, 40,000 tons in 1971, and possibly 40,000 tons in 1972. Consumption is expected to more than double in the next 5 years as new steel plants and HF plants are built. New HF plants were announced by Australian Fluorine Chemical Co. Ltd. to be built at Kooragang Island, New South Wales, and by Australia Fluorine Chemicals Pty. Ltd. at Newcastle, New South Wales.

Table 11.—Fluorspar: World production, by country
(Short tons)

Country [1]	1970	1971	1972 [p]
North America:			
Canada (shipments)	158,000	[e] 80,000	180,000
Mexico	1,078,594	1,301,779	1,149,039
United States (shipments)	269,221	272,071	250,347
South America:			
Argentina	32,689	79,624	[e] 80,000
Brazil [e]	38,600	[r] 44,100	44,000
Europe:			
Czechoslovakia [e]	90,000	100,000	100,000
France (marketable) [e]	320,000	410,000	410,000
Germany East [e]	90,000	90,000	90,000
Germany, West (marketable)	96,173	96,787	92,671
Italy	[r] 319,086	317,733	305,886
Romania [e]	17,000	17,000	17,000
Spain (marketable)	376,621	436,944	537,471
United Kingdom [2]	213,044	269,920	243,040
U.S.S.R.[e]	450,000	460,000	470,000
Africa:			
Kenya	4,303	7,232	11,527
Rhodesia, Southern [e]	165	165	165
South Africa, Republic of	190,693	263,497	232,374
Tunisia	33,841	36,331	50,742
Asia:			
Burma	[3] 182	[3] 222	248
China, People's Republic of	300,000	280,000	280,000
India	5,122	3,425	3,888
Japan	8,853	14,022	9,147
Korea, North [e]	33,000	33,000	33,000
Korea, Republic of	52,668	63,808	31,939
Mongolia [e]	88,000	88,000	88,000
Pakistan	582	5,258	2,627
Thailand	350,785	471,015	435,490
Turkey	1,835	[e] 1,200	[e] 1,200
Oceania: Australia	1,412	511	[e] 490
Total	[r] 4,620,469	5,243,644	5,150,291

[e] Estimate. [p] Preliminary. [r] Revised.
1 In addition to the countries listed, Bulgaria and Morocco also produce fluorspar, but information is inadequate to make reliable estimate of output levels.
2 Includes materials recovered from lead-zinc mine dumps.
3 Data are for year ending June 30, of that stated.

Canada.—Production resumed at better than normal rate in 1972 after the drastic dropoff in 1971 due to labor strikes. The 180,000 tons produced in 1972 was mostly acid-spar, predominantly produced by New Foundland Fluorspar Ltd., a subsidiary of Aluminum Company of Canada (Alcan). The bulk of Canada's production continues to come from the Burin Peninsula, near the village of St. Lawrence, Newfoundland. In May 1972 Alcan announced the development of a new fluorspar mine at St. Lawrence, Newfoundland, to replace the decreasing production from some of the older mines. The new mine is scheduled for production in 1976 and initially will produce 500 tons per day.[8] Nearly all of Alcan's acid-spar production was used in the firm's aluminum smelting facilities at Arvida, Quebec, where it is first processed into synthetic cryolite.

A recent announcement by International Mogul Mines Ltd. indicates that a large barite-fluorspar deposit has been developed on the east side of Lake Ainslie in Inverness County, Cape Breton Island, Nova Scotia. The barite-fluorspar veins occur in welded rhyolite tuffs, and are localized at or near the fault contact with a siltstone-shale formation. The inferred reserves total about 4 million tons containing ore assaying 28% to 50% barite and 17% to 19% fluorite. Exploitation of these deposits is not considered economically feasible at this time owing to high mining and milling costs, but production from this paramarginal deposit could become a reality if some of the metallurgy could be solved, or if the price of acid-spar increased slightly.

No production was reported from Consolidated Rexspar Minerals & Chemical's uranium-fluorspar prospect in the Birch Island area, British Columbia, or from the Conwest Exploration-Jorex partnership in the Fort Nelson (Laird River) area of northern British Columbia. Many other international companies were actively exploring in Newfoundland and British Columbia during the year.

Canadian imports of fluorspar decreased in 1972, to 72,000 tons. The 225,000 tons total imported in 1971 was unusually high because of the shutdown of Canadian mines for about 5 months.

France.—Production from France re-

[8] Northern Miner. New Fluorspar Mine to Cost Alcan $4 Million. V. 59, No. 9, May 17, 1973, p. 11.

Table 12.—Fluorspar: World trade [1] by source and destination in 1971

(Short tons)

Sources	Destinations								
	Australia [2]	Austria	Belgium-Luxembourg	Canada	Germany, West	India [3]	Italy	Japan	Netherlands
Argentina	--	--	--	--	NA	--	--	54	[5] 19,195
Brazil	--	--	--	--	NA	--	--	24,989	--
Canada	--	--	--	--	NA	--	--	--	--
China, People's Republic of	3,799	--	1,197	--	NA	--	--	106,734	--
France	701	2,051	9,557	--	[6] 69,070	--	15,441	2,484	2,136
Germany, East	--	7,350	2,471	--	NA	--	--	--	--
Germany, West	--	3,238	2,213	--	NA	[3] 3	22	--	1,339
Italy	--	2,392	--	16,838	11,584	[3] 7,737	--	--	4,078
Japan	--	--	--	--	NA	--	--	--	--
Korea, North	--	--	--	--	NA	--	--	13,519	--
Korea, Republic of	--	--	--	--	NA	--	--	52,374	--
Mexico	540	--	--	158,102	603	--	21,716	50,315	--
Mongolia	--	--	--	--	NA	--	--	--	--
Mozambique [7]	151	--	--	--	2,891	--	--	539	--
Pakistan	--	--	--	--	NA	--	--	2,004	--
South Africa, Republic of	21,124	49	--	--	30,126	([3 8])	3,207	149,160	--
Spain	--	--	--	11,270	64,025	--	--	--	--
Thailand	28	--	--	--	1,759	[3] 1,625	--	320,521	--
Tunisia	--	--	--	--	NA	--	21,407	--	--
U.S.S.R	55	--	--	--	NA	--	--	8,264	--
United Kingdom	10,518	--	--	26,232	NA	[3] 1,267	--	4,023	--
United States	--	--	--	12,651	NA	[3] 2,459	--	12,330	--
Other and/or unspecified	--	23	263	--	[6] 84,020	[3] 6,929	[9] 46,639	1	([5])
Total	36,916	15,103	15,701	225,093	264,078	[3] 20,020	108,432	747,311	26,748

See footnotes at end of table.

Table 12.—Fluorspar: World trade [1] by source and destination in 1971—Continued

(Short tons)

Sources	Destinations						Total receipts	Total recorded exports
	Norway	Poland	Sweden	U.S.S.R.	United States	Other [4]		
Argentina	--	--	--	--	--	--	19,249	31,102
Brazil	--	--	--	--	--	--	24,989	24,355
Canada	--	--	--	--	97	--	97	NA
China, People's Republic of	553	8,275	4,027	17,900	--	2,553	145,038	NA
France	389	--	9,752	--	4,489	1,109	117,179	134,718
Germany, East	--	22,485	1,760	--	--	1,516	35,582	NA
Germany, West	--	--	118	--	5,341	4,700	16,974	11,255
Italy	18,165	--	--	--	70,894	1,703	133,391	177,553
Japan	--	--	--	[10] 22,900	--	--	[10] 22,900	[10] 7,037
Korea, North	--	2,138	--	--	--	--	15,657	NA
Korea, Republic of	--	--	--	--	--	--	52,374	50,572
Mexico	--	--	--	--	850,264	780	1,082,320	1,206,068
Mongolia	--	--	--	84,000	--	--	84,000	NA
Mozambique [7]	--	--	--	--	--	1,225	4,806	--
Pakistan	--	--	--	--	--	--	2,004	NA
South Africa, Republic of	--	--	4,835	--	12,394	3,433	224,328	198,749
Spain	5,010	--	626	--	116,558	2,262	199,751	230,773
Thailand	--	--	--	46,200	--	--	370,133	370,127
Tunisia	2,425	--	--	--	--	--	23,832	NA
U.S.S.R.	--	--	--	--	--	--	8,319	NA
United Kingdom	18,675	--	385	--	--	765	61,865	[11] 73,000
United States	--	--	--	--	--	--	27,440	12,491
Other and/or unspecified	123	155	49	23,200	[12] 12,367	901	174,670	NA
Total	45,340	33,053	21,552	194,200	1,072,404	20,947	2,846,898	NA

NA Not available.
[1] Details on origin, unless otherwise specified, are from import data of countries listed as destinations, and figures in the total receipts column for each listed destination, are summations of reported imports of the listed destinations. Figures in the column headed total recorded exports are from the export statistics of the listed source countries. Differences between total receipts and total recorded exports are attributed chiefly to the time lag between date of shipment and the date of receipt, but some differences may result from either: 1) concealment policies of some countries, and/or 2) reshipment of material by intermediate countries which may be credited as the origin in the trade returns of final recipient countries.
[2] Data are for year beginning July 1, 1971.
[3] Data are for 11 months only; January, February, and April through December.
[4] Countries included and total imports by each in short tons are: Denmark—2,741; Finland—6,635; France—6,162; and Yugoslavia—5,409.
[5] The Netherlands recorded 19,195 tons total imports from undisclosed origins; Argentina recorded the export of 30,595 tons to the Netherlands in 1971. Presumably, the bulk, if not all, of the material of undisclosed origin was from Argentina and on this assumption it has been so credited.
[6] West Germany records 152,877 tons total imports from undisclosed origins (plus 213 short tons from countries specifially identified but not listed separately as origins in this table). France records the export of 69,070 tons to West Germany in 1971. On the basis of this export report, 69,070 tons has been credited to France and the other and/or undisclosed total has been reduced by a like amount.
[7] Mozambique reports no production or exports of fluorspar; apparently the imports recorded by four nations from Mozambique were shipped from other countries by way of Mozambique.
[8] Less than ½ unit.
[9] Includes 35,704 tons credited to Algeria and 8,901 tons credited to Greece, neither of which are known to be a fluorspar producer.
[10] Recorded receipts by the U.S.S.R. from Japan exceed both recorded Japanese production and exports. Japan reported the export of 6,835 tons to the U.S.S.R. in 1971; presumably the balance of the Soviet import credited to Japan was material shipped to the U.S.S.R. by way of Japan.
[11] Official estimate by The Government of the United Kingdom.
[12] The United States records 12,367 tons total imports from Switzerland, but there is no known production from that country.

mained the same at about 410,000 tons. France is self-sufficient in fluorspar, supplying all of its internal demands, and also exporting some to Austria, Belgium, Italy, West Germany, and Japan. The industry is dominated by the Péchiney-Ugine-Kuhlmann combine and Société Denain-Anzin, which consume most of their acid-spar production. Output of about 10 other smaller met-spar producers goes mostly to supply local demands.

Italy.—Italian mines produced about 306,000 tons in 1972, a small reduction from the 318,000 tons produced in 1971. However, Italy maintained its position as sixth largest producer in the world. Production is still dominated by two companies, Mineraria Silius S.p.A. of the C.E. Giulini group and the Montedison Mines Division of Montecatini-Edison S.p.A. Mineraria Silius is the world's largest individual producer of acid-spar, with a reported capacity of 250,000 tons annually. The operating companies continued to increase their identifiable reserves, which are reported to be over 14 million tons of ore averaging about 50% CaF_2.

Although Italy is a large exporter of acid-spar, it imports met-spar from France, Mexico, and the Republic of South Africa. Feasibility studies are still continuing on plans to pelletize the pyroclastic tuff and carbonatite deposits in the Castel Giuliano district, located north of Rome, to produce a 70% CaF_2 met-spar.

Japan.—Japan is the second largest consumer of fluorspar in the free world. Preliminary estimates indicate that the Japanese imported 414,600 tons of met-spar in 1972, and about 125,700 tons of acid-spar. The consumption ratio of met-spar to acid-spar was about 3⅓:1. The Japanese steel industry consumed most of the met-spar, but the Japanese chemical industry also upgraded considerable met-spar to make acid-spar and then HF. Japanese mines produce small tonnages of met-spar, usually equivalent to only a few percent of the imports.

In 1971 Japan imported 747,000 tons of fluorspar, much more than its requirements. During 1972, total imports were cut nearly 206,000 tons and the steel and aluminum industries drew heavily on stockpiled supplies. Imports from Thailand decreased from about 321,000 tons in 1971 to 252,000 tons in 1972, and imports from the Republic of South Africa were reduced from 149,000 tons to 115,000 tons. However, imports from the People's Republic of China, the third major supplier, went up slightly from 107,000 tons in 1971 to 118,000 tons in 1972. Japanese fluorspar-consuming industries like those in United States intensified their research to reduce the amount of fluorspar consumed per unit made. A mild recession in the steel and aluminum industries, also reduced the total Japanese consumption.

Nikkei Sangyo, a subsidiary of Nippon Light Metal Co. Ltd. announced the construction of the world's first commercial plant for the production of what is claimed to be a fluorspar substitute based on "red mud." The Nikkei Sangyo process blends red mud with other alumina-containing material before moulding and drying. The product known as "Alblack" contains 40% to 45% alumina, 20% to 25% iron oxide, and 8% to 10% silica, and is available as granules or as briquets. Commercial production was scheduled to start in September 1972; but, as yet, no actual figures on its effectiveness and on the quantity required per ton of steel have been released.[9]

Mexico.—Mexico maintained its position as the leading producer of fluorspar in the world, and continued to be the largest exporter to the United States, providing 78% of U.S. imports. Mexican exports to the United States averaged about half acid-spar and half met-spar, with total exports to the United States increasing about 9% in 1972. However, Mexico's world exports did not increase, and a few Mexican producers had trouble selling their ore. Some small fluorspar mines closed down, but the major producers continued at normal production rates. Table 11 indicates that Mexico's production dropped from 1,302,000 tons in 1971 to 1,149,000 tons in 1972.

Mexico's consumption of met-spar decreased in 1970–71 because the local steel industry had difficulties. In 1972, however, most of the steel plants resumed production, and programs to enlarge old plants and construct new BOF plants were announed.[10] The proposed new BOF steel plants, if constructed, will approximately double Mexico's consumption of met-spar.

Although the industrial recession of 1971 retarded investments in Mexico's chemical industry, expansion plans announced by yearend 1971 and early 1972 indicated a dramatic growth for the future, including expansion plans for new HF plants.

Two small HF plants continued to consume a little acid-spar. Most of the HF is used in the chemical industry, and a little is exported to the United States.

Progress was made on the HF plant being built west of Matamoros by Química Fluor, S.A. de C.V., which is jointly owned by the Mexican Government (Comisíon de Fomento Minero), E. I. du Pont de Nemours, Minero Frisco S.A., and Banco de Comercio. Du Pont is building the plant and will operate it for Química Fluor.

---

[9] Industrial Minerals. Interest Grows in "Red Mud" Substitute for Fluorspar. V. 60, September 1972, pp. 34, 35.

[10] U.S. Consulate General, Monterrey, Mexico. Iron and Steel: Fundidora Expansion Plans. State Department Airgram A–70, Dec. 19, 1972, p. 2.

This 70,000-ton-per-year plant is expected to go on-stream in 1975.

Metalúrgica Mexicana Peñoles S.A., Fluorita de Rio Verde S.A., and Continental Ore Corp. jointly announced the construction of a fluorspar flotation plant of 3,600-ton annual capacity. This plant was being built near the mines in the Alamos de Martinez district in Guanajuato, about 45 miles south of the Rio Verde district in San Luis Potosi, to utilize the waste piles.[11]

The Las Cuevas mine, which is owned by Sierra Minera Las Cuevas, a Noranda Mines Ltd. associate, is the largest fluorspar mine in the world. In 1972, a new flotation plant completed its first full year of operation. All told, the Las Cuevas mine produced 30,000 tons of acid-grade and ceramic-grade concentrates plus about 249,000 tons of gravel met-spar. This compares with the 356,000 tons total produced in 1971. Large stockpiles of fluorspar fines are available at this mine located in San Luis Potosi; these constitute the waste material derived from the met-spar washing and jigging plant.[12]

South Africa, Republic of.—Fluorspar production decreased 12% to 232,000 tons. Exports to the United States increased 135%, and most of the increase was in met-spar. There are five known fluorspar mines with concentrating plants plus five other mines producing small tonnages of met-spar.

Recent ore discoveries resulted in the opening of new mines and in a sharp increase of total economically minable reserves to over 50 million tons of 35% CaF_2 equivalent.[13]

A characteristic of the larger open pit mines in the Republic of South Africa is that ore grade runs only 15% to 20% CaF_2, with some as low as 10% CaF_2. However, one large operator is known to maintain a mill feed of 35% CaF_2.

In the Transvaal district, General Mining and Finance Corp. operates the Buffalo open pit mine and produced both acid-spar and met-spar. Mill feed ranged from 13% to 25% CaF_2, and mill capacity was reported at 150,000 tons annually. Some small mines in the district produced met-spar.

In the nearby Warmbath area, Montrose Exploration owned by Gold Fields of South Africa Ltd. and Allied Chemical Co. operated the Zwartkloof open pit fluorspar mine. A large reserve of 25% CaF_2 ore has been delineated. A flotation mill of 1,500-ton-per-day capacity reportedly produced a concentrate ranging from 91% to 97% CaF_2. In the Marburg district, a 45% CaF_2 ore is mined by small operators and upgraded by hand sorting and some mechanical jigging to produce met-spar.

Other companies active in fluorspar exploration and mining in the Republic of South Africa included the Vergenoeg Mining Co., the Ottoshoop Holdings, the Phelps Dodge-Minerva joint venture, U.S. Steel Co. (through the subsidiary Monico Fluorspar Co.), and the Transvaal Consolidated Land Co.

Spain.—Although production from Spain showed a dramatic increase of 23%, from approximately 437,000 tons in 1971 to 537,000 tons in 1972, the figures are questionable. Some of the production appears to be crude ore rather than finished product. Nonetheless, the country ranked somewhere between second and fourth in the world as a fluorspar producer. Spain consumes little of its production, and exports most of it to the United States, Belgium, and West Germany. Capacity is currently in excess of output, and development activities by the two main producers and others should lead to additional production in the future. Spain's fluorspar reserves are sufficient to justify expansion.

Thailand.—Thailand struggled through 1972 to maintain its position as one of the largest fluorspar producers in the world. The slump in world demand adversely affected Thailand's output, with a resultant production drop of 7.5%, from 471,000 in 1971 to 435,000 tons (70% CaF_2) in 1972 and a value decline from $42.83 per ton in 1971 to $38.09 per ton in 1972, f.o.b. Bangkok. The reported fluorspar price at the mine (loaded on truck or railroad car) averaged $35.70 per ton. Exported tonnage decreased 23% from 370,000 in 1971 to 258,000 tons in 1972. Fluorspar was Thailand's fourth largest mineral export commodity in 1972, but the total export value decreased to $10.2 million in 1972, f.o.b. Bangkok. Japan continued to be the larg-

[11] Industrial Minerals. Metalurgica Mexicana Penoles S.A. No. 57, June 1972, p. 53.
[12] Noranda Mines Ltd. 1972 Annual Report. Toronto, Canada, April 1973, 15 pp.
[13] Hodge, B. L. World Fluorspar Developments 2. Ind. Miner., June 1973, pp. 9, 10.

est buyer, receiving 229,014 tons at an average cost of $41.51 per ton c.i.f. Japanese port. The number of operating fluorspar mines in Thailand ranged from 50 to 81, but on the average there were 69 mines employing about 7,000 men.

Consumption of met-spar by the small Thai steel industry was not reported for 1971 or 1972. Total domestic consumption of fluorspar probably has been less than 10,000 tons per year. Thailand's stocks of fluorspar at yearend 1972 were probably close to 100,000 tons.

The Thai Fluorite Processing Co. Ltd.'s concentrating plant located in Petchaburi Province went on-stream in July 1972, and was officially dedicated in September 1972. This company produced about 11,000 tons of 98% CaF_2 fluorspar concentrate during 1972. Actually, Thai Fluorite's annual rated capacity is 55,000 tons of concentrate containing more than 97% CaF_2. Reportedly, Thai Fluorite has a contract with Ataka Trading Co. of Japan to deliver up to 33,000 tons of acid-spar before March 31, 1973, and an additional 33,000 tons before March 31, 1974.[14]

In March 1972, Universal Mining Co. Ltd. completed a heavy-media separating plant in the Ban Hong district near Chiengmai, Lamphun Province, about 330 miles north of Bangkok. The plant was designed and built by Head Wrightson Process Engineering Ltd. of the United Kingdom. Full production was not achieved until December. The feed is reported to come from piles of waste material accumulated in the area during the past 10 years. Reportedly the plant is expected to produce 60,000 tons of about 80%-grade fluorspar annually.[15] Crude ore from nearby mines will also be available for processing.

Leighton Mining N.L. of Australia obtained a 49% interest in Petchaburi Mining and Processing Ltd., which has been operating fluorspar mines in south-central Thailand. Historically, Petchaburi Mining has produced 30,000 tons of handsorted met-spar annually.[16] This acquisition is an indication that Australian companies are interested in obtaining a source of fluorspar for the growing steel industry in Australia.

Toyoda Tsusho Co. of Nagoya, Japan has obtained an interest in some fluorspar mines in Lamphun Province. The reserves are reported to be 150,000 tons, which may be mined by crude hand methods to produce met-spar at the rate of 3,000 tons per month.[17]

Thai fluorspar producers are aware that the People's Republic of China has made trade agreements to ship an additional 50,000 tons of met-spar annually to Japan. Thai producers hope to make up this market loss by selling at least twice that amount to the Soviet Union. Soviet trade may present transportation problems owing to a dearth of Soviet ships stopping at Bangkok.

Large-scale systematic exploration and mining are not common in Thailand. Apparently, only the most visible and accessible deposits have been mined thus far. No fluorspar reserve figures are known to have been published, but overall resources are substantial, probably exceeding 8 million tons of 50% CaF_2.

United Kingdom.—Fluorspar production in the United Kingdom decreased about 10% to 243,000 tons in 1972. Approximately four major companies and nine minor companies apparently were in operation during the year. In addition, there were eight other companies actively exploring for fluorspar. The United Kingdom continued to be self-sufficient with respect to fluorspar requirements, and there were substantial exports to several countries. United Kingdom exports were estimated to be over 40,000 tons, mostly acid-spar, in 1972. Exports may decrease, however, as demand for fluorspar by the three new domestic aluminum producers increases.[18]

TECHNOLOGY

A continuous process for the production of aluminum fluoride (AlF_3) from fluosilicic acid (H_2SiF_6) has been proposed by P. M. R. Versteegh and Thomas J. Thoonen of Unie van Kunstmestfabrieken in a paper given before the Fertilizer Society of London. The H_2SiF_6 is recovered by stand-

[14] U.S. Embassy, Bangkok, Thailand. State Department Airgram A-398, Oct. 7, 1972.
U.S. Embassy, Bangkok, Thailand. State Department Airgram A-170, May 9, 1972.
[15] Industrial Minerals. Progress in Modernising Thailand's Fluorspar Industry. No. 56, May 1972, pp. 31-33.
[16] Industrial Minerals. No. 58, July 1972, p. 37.
[17] Industrial Minerals. New Fluorspar Mine in North. No. 60, September 1972, p. 37.
[18] Hodge, B. L. World Fluorspar Developments. Ind. Miner., No. 69, June 1973, pp. 5-31.
Guccione, E. What's Going On in the Fluorspar Industry. Eng. and Min. J., v. 173, No. 12, pp. 64-75.

ard scrubbing processes in a phosphoric acid plant; then ammonia is reacted with the H_2SiF_6 to produce ammonium fluoride and to precipitate the silica and hydrated triammonium phosphate; then the ammonium fluoride is reacted with gibbsite, the source of aluminum, and after drying and calcining, AlF_3 is produced. This product with cryolite is essential as a flux in the electrolytic potlines to produce aluminum.[19]

Aluminum Co. of America at Ft. Meade, Fla., has been manufacturing AlF_3 probably by a similar process since 1971. This source of fluorine may become more common as more phosphoric acid plants are forced, due to economic or environmental reasons, to recover H_2SiF_6. More than 20 plants throughout the world are reported to be recovering H_2SiF_6.

In the United States the seven phosphoric acid plants known to be recovering H_2SiF_6 in 1972 recovered 65,100 tons of 100% H_2SiF_6. This was about 30% of the maximum total of 213,000 tons that could be recovered if all the phosphoric acid plants recovered H_2SiF_6. Approximately 40% of the H_2SiF_6 was sold for public water fluoridation, and 60% was sold to make inorganic salts for the aluminum industry. Therefore, about 39,000 tons was used by the aluminum industry, and by assuming a replacement ratio of about 1.4 tons of CaF_2 per ton of H_2SiF_6, the equivalent of 55,000 tons of CaF_2 was substituted by H_2SiF_6.

In December 1972 Reynolds Metals Co. announced that it would spend almost $6 million during 1973 on antipollution equipment at its Corpus Christi, Tex., aluminum complex. Most of the money will be spent to install electrostatic precipitators, covered conveyor systems, hoods and domes, and a tri-gas fluxing system primarily to reduce particulate and gas emissions at the electrolytic aluminum potlines. This action will undoubtedly increase recovery of fluoride compounds as particulates and fluorine gases, which may be recycled, and reduce the primary demand for Na_3AlF_6 and AlF_3.[20]

New uses for CaF_2 slags with a variable percent of AlF_3, LaF_3, and YF_3 at 1,500° to 1,600° C for electrical conductivity of metal liquids have been determined.[21]

Aluminum fluoride probably has found a new, but limited, use in the froth flotation of quartz, feldspar, and corundum by absorption or by reaction in an HF solution. The best separation of quartz took place in the acid solutions (accompanied by some formation of SiF_6). This research work has also progressed into the use of H_2SiF_6 and sodium fluosilicate (Na_2SiF_6) as activators.[22]

The American Medical Association (AMA), after the death of dogs that had breathed high concentrations of fluoroalkane gases in laboratory tests, warned the public to be careful when using aerosol sprays. The AMA also recommended against humans sniffing these gases. Laboratory tests have not been conclusive as to whether the deaths were due to a lack of oxygen or to the gases that may cause lung lesions.[23]

The Federal Bureau of Mines research centers are conducting research programs to offset the U.S. deficiency of fluorspar. Studies are continuing on the economic availability of fluorine recovered from the byproduct fluosilicic acid, and on methods to increase fluorspar or fluorine recovery from subgrade fluorspar ores, mill tailings, and industrial wastes.

[19] European Chemical News. UKF Develops Continuous Fluorine Recovery Process. V. 22, No. 535, June 2, 1972, p. 30.

[20] Corpus Christi Caller. Reynolds Allots $6 Million for Antipollution Equipment. Dec. 1, 1972, p. 4.

[21] Bacon, G., A. Mitchell, and R. M. Nishizaki. Electroslag Remelting With All-Fluoride Low Conductivity Slags. Met. Trans., v. 3, No. 3, March 1972, p. 631.

[22] Institution of Mining and Metallurgy. Role of Fluoride in the Flotation of Feldspar. V. 81, No. 790, September 1972, p. C–137.

[23] Wall Street Journal. Study May Trigger New Controversy Over Aerosol Gases. Jan. 4, 1972, p. 4.

CRYOLITE

Officially reported U.S. imports of cryolite (natural and synthetic) increased 11% to 26,000 tons in 1972. The bulk of the imports was synthetic cryolite. The largest supplier was said to be Japan, which supposedly furnished more than 10 times the tonnage exported in 1971. Japanese export figures do not confirm this, and it is suspected that transshipments from elsewhere might be included. Almost all of the Japanese shipments were synthetic cryolite. U.S. import values have not been presented in table 13 this year because of the uncertainty of reported values.

As in past years, Greenland was the only world produces of natural cryolite. During 1972 Greenland produced 65,000 tons of cryolite ore, probably from the tailings piles or dumps at the Ivigtut mine, and the ore probably assayed 50% to 60% cryolite.[24] The destination of this ore was not reported, but it was probably shipped to the Kryolitselskabet Oresund plant at Copenhagen, Denmark, where for many years the Greenland ore has been crushed, upgraded, and processed. The prime product is cryolite, but the byproducts like fluorspar, siderite, and sulfides are also produced. The Kryolitselskabet Oresund plant has a flotation section with a concentrate output capacity of about 30,000 tons annually. In 1972 Denmark exported 989 tons to the United States of what was probably natural cryolite.

For many years the Pennsylvania Salt Manufacturing Co. at Natrona, Pa., also refined cryolite ore shipped from Greenland. This company had the exclusive North American rights for processing and distribution, but in 1972 no U.S. cryolite imports from Greenland were reported.[25]

[24] U.S. Embassy, Copenhagen, Denmark. Minerals Questionnaire. State Department Airgram A-094, May 3, 1973, p. 1.
[25] Maersk, B. Cryolite Concentrator in Copenhagen. World Min., v. 9, No. 3, March 1973, pp. 40-43.

Table 13.—U.S. imports for consumption of cryolite

Year and country	Quantity (short tons)
1969	20,406
1970	21,399
1971:	
Belgium-Luxembourg	(1)
Canada	4,584
Czechoslovakia	86
Denmark	896
France	6,753
Germany, West	2,122
Greenland [2]	22
Iceland	44
Italy	5,729
Japan	1,420
Mexico	100
Netherlands	1
Poland	569
Spain	331
Switzerland	30
Yugoslavia	440
Total	23,127
1972:	
Canada	1,057
China, People's Republic of	58
Denmark [2]	989
France	2,486
Germany, West	1,503
Italy	2,549
Japan	16,677
Mexico	68
Netherlands	1
Poland	254
Total	25,642

[1] Less than ½ unit.
[2] Crude natural cryolite.

Gallium

By E. Chin [1]

Domestic production of gallium in 1972 increased sharply over production in the previous year. Most of the gallium consumption was for the production of gallium intermetallic compounds used in light-emitting diodes for electronic visual display panels. Sales of gallium-arsenide-phosphide for optoelectronic devices were estimated at $14.5 million in 1972, up from $4 million in 1971.

DOMESTIC PRODUCTION

Production of gallium metal in 1972 by two companies was more than double that in 1971. The sharp rise in production was attributed to increased demand for gallium by the electronics industry.

Gallium metal was produced as a by-product of alumina production by the Aluminum Company of America (Alcoa) at its Bauxite, Ark., plant. Gallium metal, oxide, and trichloride were produced by Eagle-Picher Industries, Inc., at its Quapaw, Okla., plant. Production data are company confidential. In addition, gallium metal and compounds produced primarily from imported material were supplied by Alusuisse Metals, Inc., Atomergic Chemetals Co., Cominco American, Inc., European Electronics, Inc., B. Freudenberg, Inc., Indium Corporation of America, Kawecki Berylco Industries, Inc., and Ventron Corp.

Alcoa announced a breakthrough in production technology which reportedly will enable the company to triple its gallium production capacity at the Bauxite, Ark., plant. Additional gallium production may be possible at Alcoa's refineries at Mobile, Ala., and Point Comfort, Tex.

Canyon Land 21st Century Corp. (Canyon Land), Blanding, Utah, is expected to begin production of gallium in late 1973. Canyon Land will use as its raw material source, gallium contained in phosphate residues, which will be provided by the Monsanto Company.

CONSUMPTION

The largest use of gallium was in electronic applications, principally in the form of gallium arsenide and gallium phosphide, which are used in solid state lamps (light-emitting diodes, LEDS). Due to the pronounced trend of the electronics industry towards microminiaturization, LEDS were increasingly used in visual display systems in calculators, digital clocks, medical instrumentation, multiple warning lights, and instrumentation for aircraft and automotive dash panels. A novel use for LEDS was in the production of electronic watches in which the time display system is based on a gallium lamp matrix. The manganese-doped magnesium-gallium spinel ($MgGa_2O_4$:Mn) is a green phosphor used in ultraviolet excitation and is used in fluorescent lamps in Xerox copying machines. Gallium compounds were also used in semiconductor applications for microswitching devices and in microwave and laser applications. The intermetallic compound vanadium-gallium, V_3Ga, is a superconductor with a high transition temperature and a high critical field.

In research and development there was growing interest in the gadolinium-gallium garnet, $Gd_3Ga_5O_{12}$, as a substrate material for magnetic bubble domain devices. Gallium trichloride was investigated as a Friedel Crafts reagent in organic synthesis.

[1] Physical scientist, Division of Nonferrous Metals.

Table 1.—Stocks, receipts, and consumption of gallium as reported by consumers

(Grams)

Purity	Beginning stocks	Receipts	Consumption	Ending stocks
1971:				
97.0%–99.9%	15,405	13,550	11,959	16,996
99.99%	2,444	1,674	1,608	2,510
99.999%	3,175	28,100	30,335	940
99.9999%–99.99999%	73,207	2,339,005	2,244,980	167,232
Total	94,231	2,382,329	2,288,882	187,678
1972: p				
97.0%–99.9%	16,996	10,591	12,692	14,895
99.99%	2,510	51,000	51,513	1,997
99.999%	940	10,249	1,664	9,525
99.9999%–99.99999%	167,232	5,992,586	5,010,336	1,149,482
Total	187,678	6,064,426	5,076,205	1,175,899

p Preliminary.

Table 2.—Consumption of gallium, by end use

(Grams)

End use	1971	1972 p
Alloys [1]	10,124	31,116
Electronics [2]	2,037,696	4,965,717
Research and development	136,070	78,670
Unspecified uses	104,992	702
Total	2,288,882	5,076,205

p Preliminary.
[1] Dental, brazing, and specialty alloys.
[2] Primarily for light-emitting diodes; includes semiconductors and color television phosphors.

Approximately 98% of the gallium consumed in 1972 was for electronic applications. Major consuming firms included Bell and Howell Co., Bell Telephone Laboratories, Inc., Fairchild Research and Development Laboratories, Hewlett-Packard Laboratories, Laser/Diode Laboratories, Inc., Litronix Inc., Monsanto Company, Motorola, Inc., Opcoa, Inc., RCA Corp., Texas Instruments, Inc., Texas Materials Laboratories, Inc., and Western Electric Co.

Strata Physics, Inc. (Strata), a user of gallium compounds for the production of optoelectronic materials, doubled the size of its plant at Santa Clara, Calif. Orders for Strata's optoelectronic materials in 1972 were reportedly over $2.4 million.

STOCKS

Consumer stocks of gallium metal, low- and high-purity grades, totaled 1,175,899 grams as of December 31, 1972. Stocks a year earlier were 187,678 grams. Shipments of gallium metal as reported by producers, dealers, and traders in 1971 and 1972 were, respectively, 853,069 grams and 3,157,634 grams. Gallium metal stocks, in grams, as held by producers and suppliers were as follows:

Year	January 1	December 31
1971	211,362	402,875
1972	402,875	1,005,945

PRICES

The average price per gram of gallium metal as quoted by domestic producers in 1972 were as follows:

Quantity	Purity designation		
	99.99%	99.999%	99.9999% 99.99999%
50 to 999 grams	$0.90	$1.05	$1.20
1,000 to 4,999 grams	.60	.65	.80
5,000 to 24,999 grams	.55	.60	.75

For orders over 500 kilograms of gallium between 6–9's and 7–9's purity, the selling price of metal was reportedly between $0.60 and $0.65 per gram. The price of a single LED unit as quoted by Monsanto Company was as follows:

Color	Composition	Quantity			
		1–9	10–99	100–999	Over 1,000
Amber	Gallium-arsenide-phosphide	$1.50	$1.50	$1.15	$0.99
Green	Gallium phosphide	13.50	11.00	9.25	8.00
Red	Gallium-arsenide-phosphide	0.62–1.65	0.62–1.65	0.50–1.30	039–1.10

FOREIGN TRADE

Exports of gallium are not reported separately and are included in base metals and alloys, not elsewhere classified, wrought or unwrought, waste and scrap.

Total U.S. imports of gallium in 1972 were 13,372 pounds valued at $2,715,179, compared with 5,889 pounds valued at $1,182,118 in 1971. The unit value of gallium imports ranged from $290 per kilogram for material from Italy to $530 per kilogram for gallium from the United Kingdom. The average unit value of all gallium imports in 1972 was $415 per kilogram.

Table 3.—U.S. imports for consumption of gallium (unwrought, waste and scrap), by country

Country	1971		1972	
	Pounds	Value	Pounds	Value
Canada	587	$129,844	3,077	$696,186
Germany, West	403	70,712	274	45,479
Hong Kong	--	--	9	1,426
Hungary	--	--	4	680
Italy	--	--	344	45,369
Japan	1	364	34	5,985
Netherlands	133	32,693	322	74,015
Switzerland	4,319	854,662	9,099	1,795,792
United Kingdom	[1] 446	[1] 93,843	209	50,247
Total	[1] 5,889	[1] 1,182,118	13,372	2,715,179

[1] Adjusted by the Bureau of Mines.

WORLD REVIEW

Canada.—Chemalloy Minerals Limited (Chemalloy) of Toronto agreed to ship samples of the tailings containing gallium from its tantalum mining operation at Bernic Lake, Manitoba, to Cominco Ltd., Kawecki Berylco Industries, Inc., and Eagle-Picher Industries, Inc. to investigate gallium extraction from the tailings. The mine at Bernic Lake, about 100 miles north of Winnipeg, is operated through Chemalloy's wholly owned subsidiary, Tantalum Mining Corp. of Canada Limited (Tanco). In addition to tantalum ore, Tanco mines pollucite, a cesium raw material source.

Tanco obtained research assistance from the University of Manitoba and financial aid from the Manitoba Research Council to investigate gallium recovery from the Bernic Lake operation. The study includes the determination of the point of maximum concentration of gallium in the process of recovering tantalum and the development of a gallium extraction process.

Cominco Ltd. recovered gallium as a byproduct from its zinc plant at Trail, British Columbia.

Japan.—Gallium production in Japan for 1968–72, estimated by the Japan Society of Newer Metals, was as follows:

Year	Kilograms
1968	100
1969	150
1970	175
1971	210
1972	500

Gallium production in 1972 was by the Dowa Mining Co., Ltd. and Nippon Light Metal Co., Ltd. Gallium intermetallic compounds were manufactured by Mitsubishi Metal Corp., Nippon Light Metal Co., Ltd., Sumitomo Electric Co., Ltd., and Sumitomo Metal Mining Co., Ltd.

Sumika Alusuisse Gallium Ltd. (Sumika), a joint venture between Swiss Aluminium Ltd. (Alusuisse) and Sumitomo Chemical Co., was formed in Japan to produce gallium metal as a byproduct of alumina production. Sumika was to establish a $2.5 million plant at Nijhama with a gallium production capacity of 2,000 kilograms per year; initial startup was scheduled for late 1973. Alusuisse was to provide the technical know-how for the installation and operation of the plant.

Dowa Mining Co., Ltd. (Dowa) increased its gallium production capacity from 5 kilograms per month to 100 kilograms per month at its Kosaka (Akita Prefecture) plant. The gallium raw material source for the Kosaka plant was from residues from the Iijima zinc smelter which is operated by Dowa's subsidiary, Akita Zinc Co. (Akita Zinc). Akita Zinc reportedly produced sufficient residue to allow recovery of 200 kilograms of gallium a month.

Netherlands.—N. V. Billiton Maatschappij (Billiton), in partnership with Kawecki Berylco Industries, Inc. (KBI), formed N. V. Kawecki-Billiton Metaalindustrie (Kawecki-Billiton), which replaced the Special Metals Division of Billiton. KBI became the exclusive sales agent in the United States and Canada for Kawecki-Billiton's ultra-high-purity metals which, in addition to gallium, include antimony, arsenic, bismuth, cadmium, copper, gold, indium, lead, tellurium, and tin.

World producers of gallium by company, location, and raw materials source are as follows:

Country	Company	Location	Source
Canada	Cominco Ltd	Trail, British Columbia	Zinc ore.
China, People's Republic of	NA	NA	NA.
Czechoslovakia	NA	NA	NA.
France	Alusuisse France S.A.	Marseilles	Bauxite.
Germany, West	Martinswerk G.m.b.H. fur Chemische und Metallurgische Produktion.	Bergheim/Erft.	Do.
Hungary	NA	NA	NA.
Italy	Società Alluminio Veneta Azioni	Porto Marghera	Bauxite.
Japan	Dowa Mining Co., Ltd	Kosaka	Zinc ore.
	Nippon Light Metal Co., Ltd	Shimizu	Bauxite.
	Sumika Alusuisse Gallium Ltd	Nijhama	Do.
	Toho Zinc Company	Fujioka	Zinc ore.
Norway	Vigeland Metal Refinery A/S	Vigeland	High-purity aluminum.
Switzerland	Alusuisse Research Laboratories	Neuhausen am Rheinfall.	Crude gallium metal.
U.S.S.R.	NA	NA	NA.
United States	Aluminum Company of America	Bauxite, Ark	Bauxite.
	Eagle-Picher Industries, Inc	Quapaw, Okla	Zinc ore.

NA Not available.

TECHNOLOGY

International Business Machines Corp. announced the development of a new type of solar cell that is more efficient than existing cells in converting sunlight to electricity.[2] The new solar cell was capable of converting 18% or more of the energy of the sunlight into electricity, older cells were typically 11% to 13% efficient. The cell is composed of a gallium arsenide layer and a layer of gallium-aluminum-arsenide doped with zinc atoms. The new cell reportedly could operate at higher temperatures than other cells and was more resistant to electron and proton radiation.

Crystals of gadolinium-gallium-garnet were produced at the Bell Laboratories using a computer-controlled crystal-growing method.[3] In this method, a digital scale records the weight of the molten material from which the rare-earth garnet is drawn. The computer uses the change in weight of the molten metal to calculate the rate of change of the crystal weight, which provides an indication of the diameter of the crystal as it is formed. The gadolinium-gallium-garnet is used as a substitute material for magnetic bubbles, a new development by the Bell Laboratories, for information storage in electronic switching systems and in computers.

GEC-Marconi Electronics of Chelmsford, England, developed a compact, thin radar

[2] Wall Street Journal. New-Type Solar Cell Developed by IBM. V. 179, No. 93, May 11, 1972, p. 15.

[3] American Metal Market. Crystals of Gadolinium Produced at Bell Labs. V. 79, No. 176, Sept. 26, 1972, p. 11.

display screen based on a matrix of light-emitting gallium-arsenide-phosphide diodes.[4] The new screen is reported to be more functionally reliable and, because it uses less than 20% of the power of conventional cathode ray tubes, it runs at a much lower temperature.

The RCA Laboratories in Princeton, N.J., produced the first instance of superconductivity of an alloy containing only two elements at a temperature higher than 20° K.[5] The new material, niobium-gallium, was superconductive at 20.3°K, which could reduce cooling costs for the superconductive phenomenon by 75% and could hasten practical applications in electric motors, generators, and transmission lines.

A patent was issued on the recovery of gallium values from circulating aluminate solution used in the Bayer process for producing alumina.[6]

The proceedings of a conference held at Pebble Beach, Calif., on optoelectronics were published by the Materials Research Corporation.[7] Papers on the technology of growing single crystals of gallium arsenide and gallium phosphide and the evaluation of optoelectronic materials were included in the proceedings.

---

[4] Chemical and Engineering News. Concentrates—Technology. V. 50, No. 37, Sept. 11, 1972, p. 16.

[5] Chemical and Engineering News. Concentrates—Technology. V. 50, No. 35, Aug. 28, 1972, p. 13.

[6] Mihake, S. (assigned to Chuo Tatemono Co., Ltd.). Electrowinning. U.S. Pat. 3,677,918, July 18, 1972.

[7] Materials Research Corporation. Optoelectronics, The Technology of Optoelectronic Materials. Orangeburg, New York, 1972.

Gem Stones

By Robert G. Clarke [1]

Although no formal gem stone mining industry exists in the United States, production in 1972 was estimated to be $2.7 million, an increase of 4% over the value of production in 1971. Individual collectors accounted for most of the quantity and value. Members of clubs in all States collected mineral specimens and rock samples. A few deposits were operated for the production of rough material that was sold directly to wholesale or retail outlets and sometimes to jewelry manufacturers.

DOMESTIC PRODUCTION

Gem stone production was estimated to be $1,000 or more for each of 38 States. The following States accounted for 77% of the total production, in thousands: Oregon, $793; California, $215; Arizona, $168; Texas, $163; Washington, $163; Wyoming, $142; Colorado, $131; Montana, $120; Nevada, $110; and Idaho, $105.

The State of Arkansas purchased the only diamond mine area in North America for development as a State park.[2] The property amounted to 867 acres, including the 78-acre diamond-producing crater. The cost was $750,000.

A find of semiprecious tourmaline was reported at the Vevel Pit on Plumbago Mountain, near Newry, Maine.[3] High value estimates were made for the find because of the large quantity of watermelon tourmalines, 3 inches in diameter, 4 to 5 inches long, green on the outside and pink inside.

The Ruggles mine, near Grafton, N.H., the oldest mica mine in the United States, was reopened to tourists and rock collectors on a fee basis.[4] The mine was originally opened in 1803 and was operated for the production of feldspar from 1932 to 1959. About 150 minerals have been found at the Ruggles mine. The list, in addition to mica and feldspar, includes amethyst, beryl, rose and smoky quartz, aquamarine, garnet, gummite, autunite, and zircon.

Tourists to the Mt. Washington Valley area of the White Mountain National Forest obtained collector's permits free of charge from the U.S. Forest Service Headquarters at Laconia, N.H.[5] The permit allowed hobby collecting only and required restoring work areas. Minerals mentioned as collected included smoky quartz, amethyst, topaz, feldspar, mica, and other pegmatite minerals.

Mines and minerals of the State of Virginia were described in a four-part series.[6]

A 10,000-pound boulder of jade was cut at the Majestic Jade Co., Riverton, Wyo.[7] The boulder was one of several removed by the company from its Verla-Irene operations near Jeffrey City, Wyo. After cutting, the jade sold for an average of $10 per pound.

Descriptions of field trips, events, and mineral and gem stone finds were reported throughout the year by Gems and Minerals, Lapidary Journal, Mineralogical Record, and Rocks and Minerals.

---

[1] Physical scientist, Division of Nonmetallic Minerals.
[2] Arkansas Gazette (Little Rock, Ark.). Crater of Diamonds Land is Purchased by State. Mar. 15, 1972, p. 17.
[3] Shevis, A. $1 Million Value Newry Tourmaline Trove Is Found. Daily Kennebec Journal, Augusta, Maine, Nov. 18, 1972, pp. 1–2.
[4] Bohlin, V. Gems To Fall From the Sky. Herald Traveler and Boston Record American (Boston, Mass.), Sept. 6, 1972, p. 22.
[5] Morrisey, C. There's Quartz in Them Thar Hills. New Hampshire Sunday News (Manchester, N.H.), Sept. 3, 1972, pp. 31, 37.
[6] Morrill P. Virginia Mines and Minerals. Rocks and Minerals. Part I; No. 393, v. 47, No. 6, June 1972, pp. 363–371. Part II; Nos. 394–395, v. 47, Nos. 7–8, July–August 1972, pp. 435–444. Part III; No. 396, v. 47, No. 9, September 1972, pp. 515–523. Part IV; No. 397, v. 47, No. 10, October 1972, pp. 587–596.
[7] Star-Tribune (Casper, Wyo.). More To Come. Jan. 6, 1973.

CONSUMPTION

Domestic gem stone output generally went to rock, mineral, and gem stone collections, objects of art, and jewelry. Apparent consumption of gem stones (domestic production plus imports minus exports and reexports) increased to $423 million, compared with $311 million in 1971, because of greater imports of diamond.

PRICES

During 1972, representative price ranges for first-quality, cut and polished, unmounted gem diamond were 0.25 carat, $100 to $400; 0.5 carat, $300 to $1,000; 1 carat, $700 to $3,500; 2 carats, $2,000 to $11,500; and 3 carats, $3,500 to $25,000. The median price for each range was 0.25 carat, $200; 0.5 carat, $550; 1 carat, $1,675; 2 carats, $4,500; and 3 carats, $9,000.

FOREIGN TRADE

Exports of all gem materials amounted to $184.9 million, and reexports, to $110.9 million. Diamond was 93% of the value of exports and 92% of the value of reexports. U.S. exports of diamond in 1972, on which work was done prior to reexport, amounted to 371,381 carats valued at $172.3 million. Of this, diamond, rough or uncut, suitable for gem stones, not classified by weight, was 345 carats valued at $18,975; cut but unset, not over 0.5 carat, was 63,780 carats valued at $11.5 million; and cut but unset, over 0.5 carat, was 307,256 carats valued at $160.8 million.

Reexports of diamond, on which no work was done, amounted to 1,430,244 carats valued at $101.9 million in categories as follows: Rough or uncut, suitable for gem stones, not classified by weight, 1,335,606 carats valued at $79.0 million; cut but unset, not over 0.5 carat, 40,384 carats valued at $7.7 million; cut but unset, over 0.5 carat, 54,254 carats valued at $15.2 million.

The six leading recipients of diamond exports and reexports accounted for 94% of the carats and 86% of the value and were as follows: Israel, 609,121 carats valued at $41.0 million; Belgium, 435,075 carats valued at $28.5 million; Switzerland, 203,209 carats valued at $37.7 million; Netherlands, 177,003 carats valued at $40.0 million; Japan, 154,497 carats valued at $34.7 million; and Hong Kong, 112,124 carats valued at $71.1 million.

Exports of all other gem materials amounted to $12.6 million. Of this total, pearls, natural and cultured, not set or strung, were valued at $0.2 million. Natural precious and semiprecious stones, unset, were valued at $9.7 million; synthetic or reconstructed stones, unset, were valued at $2.7 million. Reexports of all other gem materials amounted to $9.0 million. Reexports of pearls amounted to $0.3 million; of natural precious and semiprecious stones, unset, to $8.5 million; and of synthetic or reconstructed stones, unset, to $0.2 million.

Imports of gem material increased 36% in value compared with that of 1971. Diamond accounted for 88% of the total value of gem stone imports.

The four leading suppliers of diamond imports were as follows: United Kingdom, 1,334,000 carats valued at $182.2 million; Belgium-Luxembourg, 1,275,000 carats valued at $158.1 million; Republic of South Africa, 980,000 carats valued at $108.3 million; and Israel, 890,000 carats valued at $103.4 million.

Imports of emeralds increased 63% in quantity and 187% in value. Of 30 countries supplying natural emeralds to the United States, India furnished 276,198 carats valued at $6.2 million; Brazil, 90,483 carats valued at $1.5 million; and Colombia, 26,635 carats valued at $7.2 million. Also furnishing emeralds to the United States, but for which the country of origin was unknown, were Switzerland, 31,266 carats valued at $2.3 million; Hong Kong, 52,905 carats valued at $1.4 million; United Kingdom, 31,634 carats valued at $1.2 million; and France, 4,979 carats valued at $1.0 million. These seven countries furnished 90% of the quantity (in carats) and 94% of the value of total emerald imports.

Imports of rubies and sapphires increased 61% and came from 31 countries. Seven countries accounted for 95% of the value of rubies and sapphires, as follows: Thailand, $7.3 million; Sri Lanka (Ceylon), $1.5 million; Switzerland, $1.0 million; India, $1.0 million; Hong Kong, $0.7 million; France, $0.5 million; and United Kingdom, $0.5 million.

Synthetic materials, gem stone quality,

Table 1.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1971 Quantity	1971 Value	1972 Quantity	1972 Value
Diamonds:				
Rough or uncut	2,742	254,575	3,096	338,624
Cut but unset	1,925	208,667	2,410	288,055
Emeralds: Cut but unset	351	7,731	573	22,176
Rubies and sapphires: Cut but unset	NA	8,206	NA	13,172
Marcasites	NA	1	NA	96
Pearls:				
Natural	NA	364	NA	571
Cultured	NA	6,895	NA	7,615
Imitation	NA	5,013	NA	3,707
Other precious and semiprecious stones:				
Rough and uncut	NA	3,532	NA	6,210
Cut but unset	NA	13,456	NA	17,238
Other, n.s.p.f	NA	734	NA	1,107
Synthetic:				
Cut but unset number	11,040	9,492	16,957	10,571
Other	NA	137	NA	165
Imitation gem stones	NA	7,180	NA	6,829
Total	NA	525,983	NA	716,136

NA Not available.

Table 2.—U.S. imports for consumption of diamond (exclusive of industrial diamond), by country

(Thousand carats and thousand dollars)

Country	1970 Rough or uncut Quantity	1970 Rough or uncut Value	1970 Cut but unset Quantity	1970 Cut but unset Value	1971 Rough or uncut Quantity	1971 Rough or uncut Value	1971 Cut but unset Quantity	1971 Cut but unset Value	1972 Rough or uncut Quantity	1972 Rough or uncut Value	1972 Cut but unset Quantity	1972 Cut but unset Value
Belgium-Luxembourg	64	6,572	863	103,705	88	9,092	1,036	113,626	64	10,706	1,211	147,392
Brazil	31	1,184	1	80	3	129	2	232	(1)	26	3	321
Canada	2	462	1	60	--	--	1	69	--	--	1	82
Central African Republic	165	5,826	--	--	208	6,785	--	--	207	6,587	--	--
France	4	195	27	2,550	21	634	31	2,514	33	1,564	23	1,895
Germany, West	2	117	4	516	1	121	2	210	(1)	31	3	324
Guyana	26	1,074	(1)	19	1	49	(1)	19	2	96	(1)	6
India	--	--	40	3,475	--	--	80	6,429	--	--	186	16,507
Israel	52	6,723	604	61,753	47	3,425	671	69,569	38	5,120	852	98,316
Japan	(1)	20	(1)	18	(1)	33	2	203	--	--	1	129
Liberia	6	1,893	--	--	17	3,797	(1)	66	3	1,611	(1)	67
Netherlands	23	7,886	13	1,899	31	6,190	20	2,440	37	10,948	15	2,266
Sierra Leone	--	--	6	814	281	14,331	4	527	164	15,593	3	324
South Africa, Republic of	593	54,571	26	6,868	904	83,389	25	6,388	953	100,059	27	8,286
Switzerland	4	354	1	262	16	3,149	11	1,156	47	2,269	8	1,188
U.S.S.R	--	--	44	6,826	--	--	24	3,324	--	--	35	5,802
United Kingdom	1,432	140,243	6	970	947	118,913	12	1,366	1,302	178,659	32	3,586
Venezuela	223	6,333	--	--	177	4,283	--	--	244	5,118	--	--
Other	6	711	6	918	(1)	255	4	529	2	237	10	1,564
Total	2,633	234,164	1,642	190,733	2,742	254,575	1,925	208,667	3,096	338,624	2,410	288,055

[1] Less than ½ unit.

cut but not set, and including others, amounted to $10.7 million in imports. From West Germany, the value of synthetics was $3.8 million; from Switzerland, $1.5 million; from France, $1.0 million; from Japan, $0.9 million; and from Austria, $0.8 million.

Marcasites, cut, not set, and suitable for jewelry were imported from two countries. From France, the value of marcasites was $77,000, and from Israel, $19,000.

Precious and semiprecious stones, rough and uncut, amounted to $6.2 million in imports. Three countries accounted for 75% of the value as follows: Colombia, $2.7 million; Brazil, $1.0 million; and Australia, $0.9 million.

Precious and semiprecious stones, cut but not set, amounted to $17.2 million in imports. Six countries accounted for 86% of the value as follows: Hong Kong, $7.8 million; Brazil, $2.2 million; Australia, $2.2 million; West Germany, $1.3 million; Japan, $0.9 million; and Taiwan, $0.5 million.

Natural pearls and parts imported from India were valued at $0.4 million. Other leading suppliers of natural pearls and the value of imports were as follows: France, $57,500; Hong Kong, $35,500; and Japan, $29,000. Imports of cultured pearls from Japan were valued at $7.3 million. Cultured pearls were also imported from Hong Kong valued at $112,600; from Burma, $89,000; and from Switzerland, $67,600.

Four countries accounted for nearly 100% of the value of imports of imitation pearls, as follows: Japan, $3.0 million; Hong Kong, $0.5 million; Taiwan, $0.2 million; and Spain, $0.04 million.

Of 18 countries supplying imitation gem stones to the United States, five countries accounted for 97% by value, as follows: Austria, $3.2 million; West Germany, $1.9 million; Czechoslovakia, $0.8 million; Japan, $0.4 million; and Hong Kong, $0.3 million.

WORLD REVIEW

Angola.—The consortium composed of Companhia de Diamantes de Angola (45%), De Beers Consolidated Mines, Ltd. (45%), and the Angolan Government (10%) reported the finding of two promising and extensive kimberlite deposits in its concession area.[8] No announcement of significant finds during the past year was made by the smaller companies.

Australia.—Australian production of natural sapphire was the world's largest in 1970.[9] Recovery of alluvial sapphires were mainly from Swanbrook Creek near Inverell and from Frazer Creek near Glen Innes, both in New South Wales. Dominion Mining, Ltd. commissioned a new $600,000 sapphire washing plant, claimed to be the world's largest. The sapphires ranged from colorless to dark blue, blue green, green, yellow, and blue yellow. A large portion of the marketable gems weighed more than 1 carat each, and some weighed as much as 40 carats.

Botswana.—The Orapa diamond mine, which became fully operational in June 1972, was the only producer of diamonds. It was estimated that 85% of the diamond production by weight was industrial diamond, and that 50% of the value was gem stone. About 8,540 tons per day were mined from the open pit. Little additional cost would be involved to expand processing by 50% should the market demand warrant the increase.[10]

Brazil.—Mineração Tejucana S.A. continued to be the largest diamond mining operation. The company operated two electric bucket dredges (12- and 9-cubic-foot buckets) on the Jequitinhonha River 54 miles north of Diamantina, Minas Gerais. The company also operated a suction dredge to remove barren sand ahead of the bucket dredges. Early in 1972, a large aquamarine weighing 65 kilograms was found near Ihla Grande, Municipio of Itaobim, Minas Gerais, and was the largest found in Minas Gerais since 1947.

Burma.—Burma's Eighth Annual Gem, Jade, and Pearl Emporium closed March 5, 1972, with reported sales of US$2.3 million, a 12% decrease from the previous year's record sales.[11] Jade was the biggest

[8] Bureau of Mines. Diamond: Angola. Mineral Trade Notes, v. 69, No. 10, October 1972, p. 3.
[9] World Mining. Mechanization Boosts Australian Sapphire Output. V. 26, No. 1, January 1973, p. 55.
[10] Bureau of Mines. Diamond: Botswana. Mineral Trade Notes, v. 69, No. 9, September 1972, p. 3.
[11] Bureau of Mines. Gem Stones: Burma. Mineral Trade Notes, v. 69, No. 6, June 1972, p. 10.

seller, accounting for US$1.7 million in sales. Several Burmese press accounts commented unfavorably on the status of the gem industry and suggested that a better system should be found. A ruby deposit was reported 60 miles northwest of Mogong, Kachin State.[12]

Guyana.—M & V Diamond Mines was incorporated in Canada under a Dominion charter with the objective of mining diamonds in Guyana.[13] The company qualified in Guyana on December 31, 1971. The company obtained five diamond locations covering a combined length of 5.5 miles on th Potaro and Kopinang Rivers in the Mazaruni Mining District, the main diamond area of Guyana.

India.—All diamond production in 1972 was from the Panna District, Madhya Pradesh. Diamond mining operations were controlled and supervised by the Government of India-owned National Mineral Development Corporation (NMDC) in collaboration with the State Government of Madhya Pradesh. About 82% of the production was gem quality. NMDC imported mine-run diamond from African sources for cutting, polishing, and reexport, which in 1971 amounted to US$28 million as imports and US$42 million as exports.

Ivory Coast.—Diamond production was the only output of the mining industry in Ivory Coast since the stoppage of manganese ore mining in 1970.[14] Société Anonyme de Recherches et d'Exploitation Minières en Côte d'Ivoire (SAREMCI) produced 250,367 carats in 1971 and aimed for a similar production in 1972. Société Diamantifere de Côte d'Ivoire (SODIAMCI) stopped activities at Sassandra and at Seguela. On the other hand, the Waston Co. put into operation in January 1971 a processing plant that produced 65,382 carats in 1971 and for which the objective in 1972 was 72,000 carats.

Lesotho.—London and Rhodesian Mining and Land Co. (Lonrho) ceased prospecting operations at Kao in Butha Buthe district that it had begun in 1969 in a search for diamond.[15] Rio Tinto-Zinc Corp. (RTZ) pulled out of Letseng-la-Terai in the Mokhotlong district after more than 3 years of prospecting and sampling. Lonrho spent approximately $1.25 million and RTZ about $3.75 million on their respective operations. Newmont Mining Corp., which began prospecting at Kao in 1971, has spent $1.9 million on its operation.

Sierra Leone.—The "Star of Sierra Leone," a 969-carat diamond, third largest ever found in the world, was sold to Harry Winston, Inc., of New York for more than 900,000 pounds sterling or over $2 million. The sale of "The Star of Sierra Leone" contributed greatly to the profits of the National Diamond Mining Co. (DIMINCO). DIMINCO is 51% owned by the Government.[16] Diamond sales represented more than 60% of all Sierra Leone official exports in 1971. The importance of the diamond mining industry to the economy resulted in further prospecting for kimberlite sources by DIMINCO to offset projected decreases in production from alluvial areas.

South Africa, Republic of.—The Republic of South Africa and the Territory of South-West Africa combined are credited with over 40% of the gem-quality diamond output of the world in the period 1966 to 1971.[17] The De Beers group of mines, open pit, underground, and coastal, accounted for over 90% of the combined output of the two countries. De Beers developed a long-term mining plan for its mines under which part of the operations will be on standby to stretch out the lives of all the mines. Also, preference can be given to the sizes of diamond stones in demand by opening mines that satisfy the demand and by closing those that do not meet the demand.

United Kingdom.—A comprehensive list of sites in England was published for collectors of gem stones and ornamental rocks.[18] General locations for 18 mineral and rock types were shown on an accompanying map.

U.S.S.R.—V-O Almazjuvelirexport, the

---

12 World Mining. Burma. Jadeite and Precious Stones. V. 26, No. 1, January 1973, p. 38.

13 Northern Miner (Toronto). Form New Company To Mine Diamonds In South America. V. 57, No. 51, Mar. 9, 1972, p. 15.

14 Ivory Coast Bureau of Mines and Geology. Translations on Africa, No. 1242. Joint Publications Research Service, No. 57754, Dec. 12, 1972, pp. 16–20.

15 Bureau of Mines. Diamond: Lesotho. Mineral Trade Notes, v. 70, No. 3, March 1973, pp. 3–4.

16 Meisler, S. Diamond Digging in Sierra Leone is Dirty Business. The Denver Post, Sept. 28, 1972, p. 47.

17 Engineering and Mining Journal. Diamonds: One of South Africa's Best Friends. V. 173, No. 11, November 1972, pp. 184–185.

18 Adamson, G. L. S. Gems and Decorative Stones in England. Mine & Quarry (London), v. 2, No. 1, January 1973, pp. 35–37.

U.S.S.R. foreign trade organization specializing in diamond and jewelry exporting, exhibited amber products and diamonds at Unimart 1972, the Annual International Trade Fair, at Seattle, Wash.[19] Representatives of U.S.S.R. claimed that the production of diamond from Siberia equals that of the Republic of South Africa in quantity and quality. It was also claimed that the Kaliningrad amber fields are the largest in the world and constitute more than two-thirds of the world's amber reserve.

Table 3.—Diamond (natural): World production by country [1]

(Thousand carats)

Country	1970			1971			1972 [p]		
	Gem	Industrial	Total	Gem	Industrial	Total	Gem	Industrial	Total
Africa:									
Angola	1,797	599	2,396	1,810	603	2,413	1,171	391	1,562
Botswana	[r]47	[r]417	[r]464	82	740	822	360	2,043	2,403
Central African Republic	313	169	482	288	149	437	346	178	524
Ghana	255	2,295	2,550	256	2,306	2,562	266	2,393	2,659
Guinea [e]	22	52	[2]74	22	52	74	25	55	80
Ivory Coast	85	128	213	130	196	326	131	199	[e]330
Lesotho [3]	4	13	17	1	6	7	1	8	9
Liberia	[4]577	[4]235	[4]812	[4]532	[4]277	[4]809	532	278	[e]810
Sierra Leone [5]	723	1,232	1,955	715	1,220	1,935	609	1,038	1,647
South Africa, Republic of:									
Premier mine	623	1,867	2,490	609	1,828	2,437	613	1,841	2,454
Other De Beers Company [6]	2,615	2,140	4,755	2,162	1,769	3,931	2,291	1,874	4,165
Other	520	347	867	398	265	663	466	310	776
Total	3,758	4,354	8,112	3,169	3,862	7,031	3,370	4,025	7,395
South-West Africa, Territory of	1,772	93	1,865	1,566	82	1,648	1,516	80	1,596
Tanzania	359	349	708	419	418	837	365	365	[5]730
Zaire	1,649	12,438	14,087	1,250	11,270	12,520	980	12,380	13,360
Other areas:									
Brazil [e]	[r]150	[r]150	[r]300	[r]150	[r]150	[r]300	155	155	310
Guyana	24	37	61	19	29	48	20	29	49
India	17	3	20	16	3	19	17	3	20
Indonesia [e]	14	6	20	12	3	15	12	3	15
U.S.S.R.[e]	1,600	6,250	7,850	1,800	7,000	8,800	1,850	7,350	9,200
Venezuela	[r]131	[r]378	[r]509	114	385	499	141	315	456
World total	13,297	29,198	42,495	12,351	28,751	41,102	11,867	31,288	43,155

[e] Estimate. [p] Preliminary. [r] Revised.

[1] Total (gem plus industrial) diamond output of 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 all countries except Lesotho (all years), Liberia (1970 and 1971) 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] Official estimate by Government of Guinea.

[3] Exports of diamond originating in Lesotho; excludes stones imported for cutting and subsequently reexported.

[4] Exports for year ended August 31 of that stated.

[5] Exports.

[6] All company output from the Republic of South Africa except for that from the Premier mines; also excludes company output from the Territory of South-West Africa and from Botswana.

TECHNOLOGY

A description of a technique to pan for diamond was published.[20] By a modification of the method used to pan for placer gold, it is possible to find diamond specimens in the United States. The specific gravity of gold is 19.3 in the pure state and may decrease to 15.0 with impurities. The specific gravity of diamond is 3.52. Hence, the difference between diamond and quartz or common sand, specific gravity of 2.7, indicates the care to be exercised in the panning operation for diamond. The technique was used by the

[19] Barnett, C. Soviet Diamonds Mined in Siberia Dazzle Onlookers at Trade Fair. J. of Commerce, v. 313, No. 22, 762, Aug. 15, 1972, p. 3.

[20] Joque, M. S. Prospecting for Diamonds. Lapidary J., v. 26, No. 10, January 1973, pp. 1501–1507.

author at localities in California. In addition, to these finds, Frank Fischer, an entrepreneur now of Lake Hamilton, Ark., applied his knowledge of diamond identification that he gained from 10 years experience in the diamond fields of Minas Gerais, Brazil, to sites south of Murfreesboro, Ark. Mr. Fischer reported diamond finds at several locations. He believed that the lack of familiarity with diamond by most collectors explains the dearth of diamond finds in the United States.

The quality of synthetic crystals was improved by application of computer controls to the growth process.[21] The system was developed for producing the rare-earth garnet (gadolinium gallium garnet or GGG) and can be adapted to growing other kinds of crystals.

At least 15 lasers were in use by diamond cutters around the world in New York, Antwerp, Israel, and India to increase the value of diamond gem stones by 100% or more.[22]

A yearlong scientific study of the patented 144-facet diamond cut showed that the new cut had an average brilliance 32.2% higher than that of the conventional 58-facet cut.[23]

The most valuable gem stone of the feldspars is moonstone. A complete description of the chemical and physical requirements for forming moonstone was presented in an article that also described means for proper identification.[24]

---

21 American Metal Market. Crystals of Gadolinium Produced at Bell Labs. V. 79, No. 176, Sept. 26, 1972, p. 11.

22 Ward, A. Pique Diamonds, Treated By Lasers On The Increase In World Markets. Jewelers' Circular-Keystone, v. 142, No. 6, March 1972, pp. 98–100.

23 Jewelers' Circular-Keystone. 144-facet diamonds more brilliant: Zeiss. V. 143, No. 3, December 1972, p. 109.

24 Rieman, H. M. Moonstone. Lapidary J., v. 25, No. 11, February 1972, pp. 1560–1564.

Gold

By J. M. West [1]

Free market gold prices rose sharply in 1972 as a result of monetary uncertainties, higher world industrial consumption, reduced supplies, and increased speculative buying of gold. The average price rose about $17 per troy ounce; the price change from the first of the year to the yearend was nearly $21 per ounce. On August 2, gold reached a record price, slightly over $70. The official price increased $3 per ounce to $38, effective May 8, 1972. U.S. official gold reserves declined 15.6 million ounces during 1972, owing mainly to transactions with the International Monetary Fund (IMF).

During 1972, domestic gold production declined to 1.45 million ounces, a drop of 3% from 1971 output. About 76% of the newly mined gold came from four producers: Homestake Mining Co., Kennecott Copper Corp., Carlin Gold Mining Co., and Cortez Gold Mines. Domestic consumption of gold rose 5% to 7.3 million ounces, with jewelry and arts accounting for 60% of the total consumed. Net imports declined 21% and industry stocks rose approximately 1% during the year.

World gold production declined in 1972, chiefly because of a continuing drop in the Republic of South Africa production. The Republic of South Africa supplied 65% of the world's newly mined production; the

[1] Physical scientist, Division of Nonferrous Metals.

Table 1.—Salient gold statistics

	1968	1969	1970	1971	1972
United States:					
Mine production ---- thousand troy ounces --	1,478	1,733	1,743	1,495	1,450
Value ---- thousands --	$58,038	$71,944	$63,439	$61,673	$84,967
Ore (dry and siliceous) produced:					
Gold ore ---- thousand short tons --	2,780	3,393	3,692	3,472	3,320
Gold-silver ore ---- do ----	199	208	W	166	169
Silver ore ---- do ----	655	655	673	574	344
Percentage derived from:					
Dry and siliceous ores ----	63	59	60	60	58
Base-metal ores ----	34	40	38	39	41
Placers ----	3	1	2	1	1
Refinery production [1] -- thousand troy ounces --	1,539	1,717	NA	NA	NA
Exports [2] ---- do ----	23,962	338	1,074	1,339	1,472
Imports, general [2] ---- do ----	5,944	5,861	6,652	7,201	6,126
Stocks Dec. 31:					
Monetary [3] ---- millions --	$10,892	$11,859	$11,072	$10,206	$10,487
Industrial ---- thousand troy ounces --	3,617	4,158	3,984	4,375	4,407
Consumption in industry and the arts -- do ----	6,604	7,109	5,973	6,933	7,285
Price: [4] Average per troy ounce ----	$39.26	$41.51	$36.41	$41.25	$58.60
World:					
Production ---- thousand troy ounces --	46,165	46,612	47,522	46,491	44,711
Official reserves [5] ---- millions --	$40,905	$41,010	$41,275	[r 6] $44,742	[6] $45,000

[r] Revised. NA Not available. W Withheld to avoid disclosing individual company confidential data; included in gold and silver ores.
[1] From domestic ores—U.S. Bureau of the Mint.
[2] Excludes coinage.
[3] Includes gold in Exchange Stabilization Fund.
[4] U.S. Treasury price through March 15, 1968, and Engelhard selling quotations March 20, 1968, through 1972.
[5] Held by free-world central banks and governments.
[6] Value based at $38 per troy ounce.

Table 2.—Salient statistics on gold, 1939–1972

(Thousand troy ounces unless otherwise noted)

Year	United States							World production			
	Production			Trade [1]		Net consumption [2]	Treasury stocks, value yearend [3] (million)	Total	Principal sources, other than U.S.		
	Total	From placers	From dry and siliceous gold and silver ores	Exports	Imports (general)				Canada	Republic of South Africa	U.S.S.R.
1939	4,673	1,334	2,794	15	101,968	213	$17,644	39,658	5,115	12,822	5,200
1940	4,870	1,511	2,706	32	126,464	380	21,995	37,104	5,333	14,097	5,100
1941	4,751	1,488	2,583	2	28,023	1,057	22,736	34,743	5,366	14,408	4,300
1942	3,457	1,014	1,730	3	9,012	1,351	22,726	36,038	4,857	14,127	3,300
1943	1,364	158	523	689	2,907	2,467	21,938	28,801	3,670	12,804	3,200
1944	998	123	298	27,402	2,872	2,780	20,619	26,145	2,938	12,280	3,200
1945	955	185	285	5,665	2,676	3,113	20,065	26,287	2,708	12,295	3,200
1946	1,575	591	622	6,323	10,917	4,391	20,529	27,651	2,833	11,927	3,300
1947	2,109	679	812	5,406	55,414	1,397	22,754	28,947	3,081	11,200	3,400
1948	2,014	601	795	5,343	55,259	1,285	24,244	29,958	3,530	11,585	3,600
1949	1,992	533	892	2,172	22,040	3,110	24,427	30,980	4,124	11,705	3,600
1950	2,394	611	1,032	14,634	4,652	2,796	22,706	32,661	4,441	11,664	3,600
1951	1,981	491	770	17,549	2,323	1,985	22,695	34,274	4,393	11,516	3,600
1952	1,893	426	748	784	21,140	2,753	23,186	33,814	4,472	11,819	3,600
1953	1,958	409	791	854	1,344	2,143	22,030	33,276	4,056	11,941	3,500
1954	1,837	420	787	494	1,083	1,270	21,713	34,632	4,366	13,237	3,500
1955	1,880	410	777	162	2,930	1,300	21,690	35,941	4,542	14,602	3,500
1956	1,827	349	779	734	3,730	1,400	21,949	37,957	4,384	15,897	3,500
1957	1,794	343	777	4,806	7,701	1,450	22,857	39,144	4,434	17,031	3,500
1958	1,739	371	806	886	8,120	1,833	20,582	40,077	4,571	17,656	3,600
1959	1,603	359	801	50	8,485	2,522	19,507	42,304	4,483	20,066	3,900
1960	1,667	264	792	47	9,322	3,000	17,804	37,312	4,629	21,383	4,100
1961	1,548	203	741	22,146	1,615	2,775	16,947	39,297	4,474	22,942	4,400
1962	1,543	265	728	10,884	4,312	3,576	16,057	41,182	4,178	25,492	4,080
1963	1,454	185	748	5,820	1,281	2,920	15,596	43,147	4,003	27,432	4,370
1964	1,456	125	796	12,078	1,169	4,801	15,471	44,841	3,835	29,112	4,650
1965	1,705	99	928	36,717	2,905	5,276	13,806	46,225	3,606	30,554	5,030
1966	1,803	92	1,038	13,067	1,200	6,062	13,235	46,580	3,319	30,880	5,370
1967	1,584	65	1,086	28,720	930	6,294	12,065	45,737	2,962	30,535	5,700
1968	1,478	37	934	23,962	5,944	6,604	10,892	46,165	2,688	31,169	5,900
1969	1,733	25	1,034	338	5,861	7,109	11,859	46,612	2,545	31,276	6,250
1970	1,743	39	1,049	1,074	6,652	5,973	11,072	47,522	2,409	32,164	6,500
1971	1,495	16	891	1,339	7,201	6,933	10,206	46,491	2,243	31,389	6,700
1972	1,450	13	841	1,472	6,126	7,285	10,487	44,711	2,079	29,245	6,900

[1] Includes monetary gold. Trade data converted from reported values at $35 per ounce, 1939–51.
[2] U.S. Department of the Treasury.
[3] U.S. Department of the Treasury. Convertible to ounces at official price of $35 per ounce through 1971 and $38 per ounce in 1972.

U.S.S.R. ranked second to the Republic of South Africa, with an estimated 6.9 million ounces produced in 1972. Third and fourth were Canada and the United States, both with declining outputs.

David Lloyd-Jacob, Manager, Consolidated Gold Fields Ltd., told a conference in London in October 1972 that he estimated the total newly mined world supply of gold coming to markets in 1972, including that from the Republic of South Africa and Russian sales, would decline 5.1 million ounces to 38.6 million ounces. Of the total, it was estimated that 16.1 million ounces would go to jewelry manufacturers in advanced countries, 11.9 million ounces-sharply lower than in 1971 to jewelry manufacturers in less developed countries, and the balance into other fabrication including coins. Substantial net dishoarding of gold was anticipated to supply rising industrial demands in 1972–73. Russian sales of gold on world markets have been estimated at 8 million ounces in 1972 and were expected to drop to 4.8 million ounces in 1973. R. C. J. Goode, President, Chamber of Mines of South Africa, predicted in an address at the same London conference that even with an immediate increase in the official gold price to $70 per ounce the Republic of South Africa production would probably decline to 26.3 million ounces by 1982. If the price was to go to $100, a 1982 output of 27.2 million ounces was predicted. Estimates took into account various factors, such as working costs, pay limits, ore reserves, etc.

Legislation and Government Programs.—Following the December 18, 1971, accord of finance ministers from 10 leading industrial nations at the Smithsonian Institution, Washington, D.C., the U.S. Congress passed a bill which was signed into law March 31, 1972, (Public Law 92–268) to devalue the dollar to the equivalent of $38 per troy ounce of gold. In early May, $1.6 billion was appropriated to adjust U.S. balances in international financial institutions to accomodate the devaluation, and on May 8, 1972, the Act became effective, changing the par value of the dollar to one thirty-eighth of an ounce of gold. A number of bills were introduced in the Congress to permit American citizens to hold gold but none of the bills reached a vote.

In a report issued November 18, 1972, by the Subcommittee on International Exchange and Payments of the Joint Economic Committee, Congress of the United States (92d Congress, 2d Session), the following recommendations were made in respect to actions on gold for the purpose of deemphasizing gold as a reserve asset:

1. The March 1968 two-tier gold agreement should be modified to permit, at their own initiative and volition, sales of gold in the free market by the IMF and central banks. On the other hand, the prohibition against central bank purchases of gold in the free market or directly from the Republic of South Africa ought to be maintained.
2. Under a reformed international monetary regime, special drawing rights should be made acceptable in lieu of gold in all transactions between the IMF and its member countries.
3. As soon as the international monetary reform that is currently being negotiated is achieved, all prohibitions on the purchases, sale, and holding of gold by American citizens should be promptly abolished.
4. The current agreement committing the IMF to purchase gold from the Republic of South Africa under certain conditions ought not to be renewed. Instead it should be terminated in 2 years when it expires. Recommendations were also made toward strengthening the special drawing rights mechanism.

A Canadian exchange opened at Winnipeg in November for trading gold futures, and because of many questions, the Treasury Gold Regulations permitting persons and firms licensed by the Treasury Department to buy and hold gold for commercial, industrial, and artistic purposes "in amounts necessary to conduct their business operations" were clarified, as follows: Under the Regulations, the purchase of gold in futures markets is treated in the same manner as other gold purchases:

1) Treasury's Gold Regulations provide that Americans may not acquire any interest in gold, at home or abroad, unless authorized by a Treasury license. This prohibition is applicable to U.S. citizens wherever residing, to noncitizens residing in the United States and to U.S. companies and their foreign subsidiaries.

2) U.S. firms and individuals authorized by a Treasury license to buy or hold gold for commercial, industrial, and

artistic purposes may engage in gold futures transactions only to an extent consistent with their licenses. Specifically, purchases of gold futures are limited in amount to the specific inventory restrictions contained in their licenses and the transactions must serve the legitimate and customary purposes of their businesses. Speculative activities by gold licensees not related to current business operations could result in the revocation of their gold licenses and subject them to the civil and criminal provisions prescribed by law.

Gold purchased for future delivery will be included in the authorized inventory of the gold licensee. Gold licensees are required to set forth their net futures position in their regular reports to the Treasury Department and their position is subject to inspection at all times.

3) U.S. firms and foreign subsidiaries of U.S. firms which are members of commodity exchanges abroad may engage in brokerage activities on such exchanges for Treasury gold licensees and for firms and individuals not subject to the jurisdiction of the United States. A Treasury gold license is not required for brokerage functions.

At the same time, brokerage firms may not acquire any interest in gold for their own account for present or future delivery. Brokerage firms engaging in brokerage activities must take reasonable measures to assure that the transactions on behalf of U.S. gold licensees serve legitimate business purposes and are consistent with the limitations contained in the gold license. They must also take reasonable measures to assure that non-U.S. citizens with whom they transact business are not acting on behalf of U.S. citizens.

The Office of Minerals Exploration (OME), U.S. Geological Survey continued its program of offering participatory loans for gold exploration up to 75% of approved costs. However, only a few relatively small loans or active contracts were approved or in effect.

DOMESTIC PRODUCTION

A decline in domestic gold production in 1972 was largely the result of a strike at the Homestake gold mine, Lead, S.D., which together with other production problems cut over 100,000 ounces from the Homestake's output. Outputs from copper mining States of Nevada, Arizona, New Mexico, and Montana, were generally higher in 1972, offsetting part of the South Dakota drop; Colorado production increased owing to greater base-and-precious-metal mine activity. A decline in Utah output was signalled by the yearend closure of the Mayflower mine, operated under lease by the Hecla Mining Co. In 1972 the Mayflower produced 46,863 ounces of gold in addition to other metals. Downtrends continued in most other States, although there was a widespread increase in prospecting and exploration activity because of higher gold prices. Golden Cycle Corp. announced a $6 million program to reactivate its mining operations in the Cripple Creek area of Colorado. Work was begun by a subsidiary, Cripple Creek Gold Corp., to rehabilitate the Carlton tunnel and rebuild mill facilities. Diamond drilling was planned in 1973 on the 3,111-foot level, reached from the Ajax shaft which was also rehabilitated. The Shenandoah mill of Standard Metals Corp., in the Silverton area, San Juan County, Colo., treated about 700 tons of ore daily from the Sunnyside mine.

In Alaska, a gold dredge which had been inactive for two seasons, was reactivated on the Solomon River, in the Nome area, and offshore gold deposits were under investigation for possible new oceangoing dredge operations at several locations. UV Industries, Inc. (formerly United States Smelting, Refining and Mining Co.) operated a gold dredge at Hogatza, in the Yukon River region. Other smaller scale placer mining was active in the Hot Springs, Fortymile, Ruby, and Iditarod districts of Alaska. In Montana, Judith Gold Corp. continued evaluation of its property in the Kendall district near Lewistown, Fergus County. Gold milling facilities were under construction in Nevada at Silver Peak, Esmeralda County; at a property near Manhattan, Nye County; and at a site near Tonopah, Esmeralda County.

Gold production dropped 21% to 407,397 ounces valued at $23.1 million in 1972 at the Homestake mine in South Dakota. Ore grade averaged 0.278 ounce of gold per ton treated compared with 0.285 ounce in 1971.

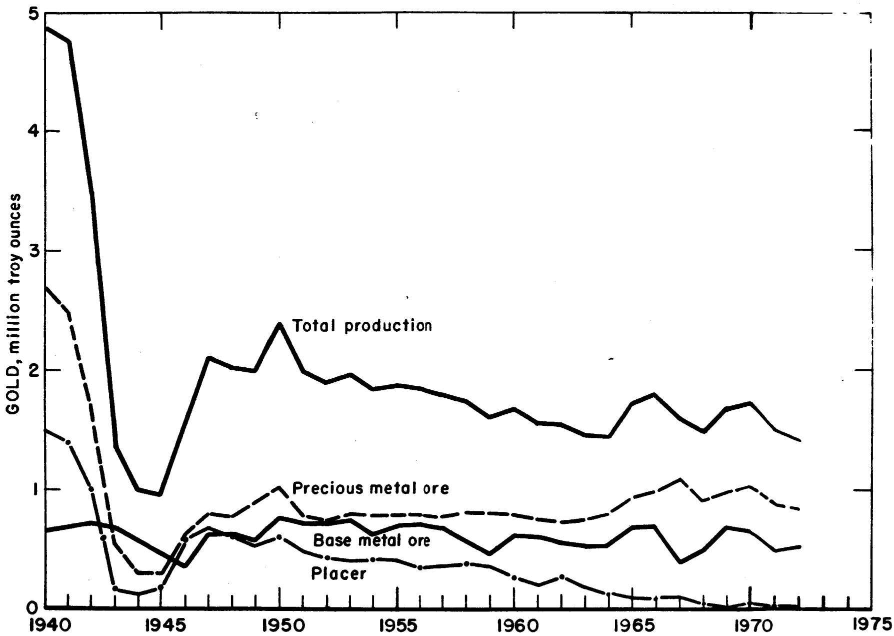

Figure 1.—Gold production in the United States.

A total of 1.47 milion tons of ore was milled. Construction of a new gold recovery unit using a "charcoal-in-pulp" process was nearly completed and was due to go into operation in early 1973. Lower gold losses were anticipated in 1973 as a result. Measured ore reserves at the Homestake mine were estimated at 7.3 million tons averaging 0.299 ounce per ton at the end of 1972. Deep level development reached the maximum project depth, shaft equipment was installed, and new working levels were driven in preparation for increased extraction rates.

At the Cortez mine, Lander County, Nev., mill throughput rose to 803,000 tons in 1972; however, the mine was due to close in early 1973 owing to ore depletion. Production increased 59% to 190,600 ounces compared with 120,251 ounces produced in 1971. The average grade milled was 0.214 ounce per ton and 88.9% was recovered. A large low-grade waste dump, containing 1.6 million tons of mine-run material, was constructed for cyanide "heap-leaching" and during the year 37,600 ounces was produced by this low cost method. Material in the waste dump was estimated to average only about 0.06 ounce per ton and ultimate extraction was expected to be 50% or higher. Cortez Gold Mines also conducted studies in the nearby Gold Acres area and planned to establish a heap-leach/activated carbon extraction operation there, trucking any quantities of milling grade ores found to the Cortez mill for treatment.

The Carlin mine, Eureka County, Nev., produced 194,000 ounces of gold compared with 199,000 ounces in 1971. Sales were valued at $11.7 million compared with $8.3 million in 1971. The average grade of ore milled was 0.238 ounce per ton, compared with 0.287 ounce per ton in 1971. Heap-leaching was credited with recovery of about 2% of the gold, with the balance from treating better grade oxidized and carbonaceous ores in the established milling circuits. Investigations and production planning continued at the Bootstrap deposit, which was expected to be partly a heap-leach operation, with the better ores hauled to the Carlin cyanide plant for processing. Another deposit nearby, the Blue Star, was also scheduled for development. Ore reserves at the main Carlin deposit were estimated at yearend to be 2.71 million tons averaging 0.317 ounce per ton.

This compared with 3.5 million tons averaging 0.297 ounce per ton at yearend 1971. Combined reserves at the Bootstrap and Blue Star deposits were estimated at 1.1 million tons of somewhat lower grade ore. Production was scheduled at the latter two deposits about yearend 1973. Carbon-column gold extraction units underwent testing at each major gold operation (Homestake, Cortez, and Carlin) and were expected to lead to more efficient production.

At Bingham, Utah, the Utah Copper Division, Kennecott Copper Corp., remained the principal byproduct gold producer, reported gold production, mostly from the Bingham pit totaling 350,080 ounces in 1972. The Knob Hill gold mine, operated in conjunction with the Gold Dollar property of Day Mines, Inc., in the Republic district of northeastern Washington, was a continuing source of gold; reserves reportedly were adequate for about 2 more years of operation. Day Mines' share of production from the Gold Dollar Lease was 15,281 tons of ore milled averaging 0.85 ounce of gold and 2.34 ounces of silver per ton. The firm's share in output from a joint operation with Knob Hill Mines, Inc., was 12,255 tons of ore averaging 0.43 ounce of gold and 2.5 ounces of silver per ton. An $80,000 diamond drilling program was scheduled in 1973 to develop further reserves.

Production from the Mayflower mine, located in the Park City district of Utah and leased from Newpark Resources, Inc. by Hecla Mining Co., included 46,863 ounces of gold. Accompanying the gold were 620,024 ounces of silver, 3,586 tons of lead, 2,163 tons of zinc, and 1,495 tons of copper. A total of 114,604 tons of ore was produced. At yearend, Hecla terminated its lease, owing to depleted ore reserves, and closed the mine.

All but a few thousand ounces of Colorado's gold production in 1972 came from the Sunnyside mine, operated by Standard Metals Corp.; the Idarado mine, operated by Idarado Mining Co.; and the Leadville mine, operated by American Smelting & Refining Co. The latter mines were operated primarily for base metals, with the gold as a byproduct.

Of total U.S. gold production, the leading four producers, Homestake Mining, Kennecott Copper, Carlin Gold Mining, and Cortez Gold Mines, contributed 76%; 98% of the total was accountable to 25 leading producers (table 6). Placer and byproduct gold production accounted for 1% and 4%, respectively, of total gold output. An estimated 2.1 million ounces of secondary gold was produced compared with 2.2 million ounces in 1971.

CONSUMPTION AND USES

Domestic consumption of gold, as reported by the Office of Domestic Gold and Silver Operations, U.S. Department of the Treasury, rose 5% to 7.3 million ounces in 1972. Consumption in 1972, as indicated by reports of fabricators of industrial and other products, was divided, as follows, in thousand ounces (with 1971 figures for comparison): Jewelry and arts, 4,344 (4,299); dental, 750 (750); and industrial, including space and defense 2,191 (1,884). Increases in most categories were the result of an upsurge in the U.S. economy and greater affluence.

Consumption was undeterred by sharply higher gold prices, although manufacturers noted increasing efforts to substitute other metals, use thinner plating, cover smaller areas of products, and lower the carat content of gold. Most users were reported "by choice or by lack of a suitable substitute, to be sticking with gold and the higher costs involved."[2] Increased costs were passed on to consumers of many products, notably jewelry purchasers, but for a variety of reasons some manufacturers had to absorb the increases themselves. Electronic products makers were particularly hard pressed because of intense competition and were reported investing in more spot-plating and selective plating equipment in 1972.[3] Palladium was used more in contact and connector points as a base for reducing the thickness of gold. Some increase in substitution of tin for gold was noted in the manufacture of printed circuit boards.

[2] Wall Street Journal. Guessing About Gold: Metal's Unsettled Price Confuses Firms; Some Hold Off Buying, Others Build Stocks. V. 180, No. 113, June 12, 1972, p. 34.

[3] Snyderman, Nat. Price Pressures May Hit Gold Vendors to Electronics Firms. Am. Metal Market, v. 79, No. 156, Aug. 28, 1972, p. 61.

One firm offered a new customer's service to solve technical problems with contact bimetal materials.[4] Other firms sent technical representatives to plating plants to advise customers on ways to economize on use of gold. It was contended that gold plating operators lost from 10% to 60% of their gold because of inefficiencies.[5] A new form of gold salts to provide more uniform gold plating was said to have been developed.[6] A superior doped gold ribbon and wire product was developed,[7] and a gold-coated foil was used in an experimental telephone needing no metal contacts for dialing.[8] A substitute dental alloy using titanium or chrome base alloys instead of gold was marketed,[9] and gold-plated beryllium-copper radar waveguides were used in the new Hawk missile.[10]

STOCKS

Monetary.—Official U.S. gold stocks, including those in the Exchange Stabilization Fund, were valued at $10,487 million based on $38 per ounce gold at the end of 1972 compared with $10,206 million based on $35 per ounce gold at the end of 1971. The equivalent amounts of gold were 276.0 million ounces at the end of 1972 compared with 291.6 million ounces a year earlier for a net outflow of 15.6 million ounces. Virtually all of the outflow was the result of a resale of gold to the IMF in the early part of the year. Suspension of convertibility of dollars to gold, begun in August 1971, remained in effect at yearend 1972.

Federal Reserve Banks held $15,530 million (408.7 million ounces at $38 per ounce) worth of "earmarked" gold at the end of 1972 for foreign and international agency accounts. This compared with $13,815 million (394.7 million ounces at $35 per ounce) at the end of 1971. Total gold stocks of national monetary authorities and international institutions (excluding the U.S.S.R., other Eastern European countries, and the People's Republic of China) were valued at an estimated $45,000 million at the end of 1972 compared with $44,742 a year earlier. Stocks were equivalent to about 1,184 million troy ounces compared with 1,177 million ounces at yearend 1971, indicating an accumulation of nearly 7 million ounces.

World monetary gold stocks at the end of 1972 were distributed, as follows, in million ounces: United States (276.0); IMF (153.3); West Germany (117.3); France (100.6); Switzerland (83.1); Italy (82.3); the Netherlands (54.2); Belgium (43.1); Portugal (26.9); Canada (21.9); Japan (21.1); Republic of South Africa (17.9 compared with 10.8 at end of 1971); Spain (14.2); Venezuela (11.2); Bank for International Settlements (5.7); and others (155.2). The largest gain in stocks was with the IMF, which acquired about 18.2 million ounces, mainly from the United States, as a result of dollar devaluation. "Paper gold" Special Drawing Rights (SDR's) in the IMF totaled 9,431 million at the end of 1972 compared with 6,378 million at the end of 1971, an increase of 3,053 million. The SDR's, created to increase world money liquidity, were the official equivalent of 269.5 million ounces of gold (the unit of SDR by definition is equivalent to 0.888671 gram of fine gold). Thus, SDR's added to amounts in existence at yearend 1971 were equivalent to 87.2 million ounces of gold, over twice the free-world mine production of gold during 1972.

Industrial.—Inventories of gold at domestic refiners and fabricators rose approximately 1% during 1972, to 4.41 million ounces, according to data collected by the Office of Domestic Gold and Silver Operations.

---

4 Belos, Rick. Engelhard Group Has Answers To Contact Bi-Metal Queries. Am. Metal Market, v. 79, No. 155, Aug. 25, 1972, p. 17.

5 American Metal Market. Technic Chief Warns Gold Users Rising Market Good Time To Stay on Toes. V. 79, No. 109, June 12, 1972, p. 10.

6 ———. Say New Form of Gold Salts Prolong Life of Plated Parts. V. 79, No. 155, Aug. 25, 1972, p. 8.

7 ———. Alloying & Precious Metals: Close Control or Doped Gold Claimed. V. 78, No. 237, Dec. 13, 1971, p. 14.

8 ———. Layer of Gold Plays Part in Bell Dialing Mechanism. V. 80, No. 25, Feb. 5, 1973, p. 27.

9 ———. Dentillium May Replace Some Dental Gold Uses. V. 79, No. 169, Sept. 15, 1972, p. 6.

10 ———. Hawk Missile Waveguides Use Gold Plated Beryllium Alloy. V. 79, No. 145, Aug. 7, 1972, p. 29.

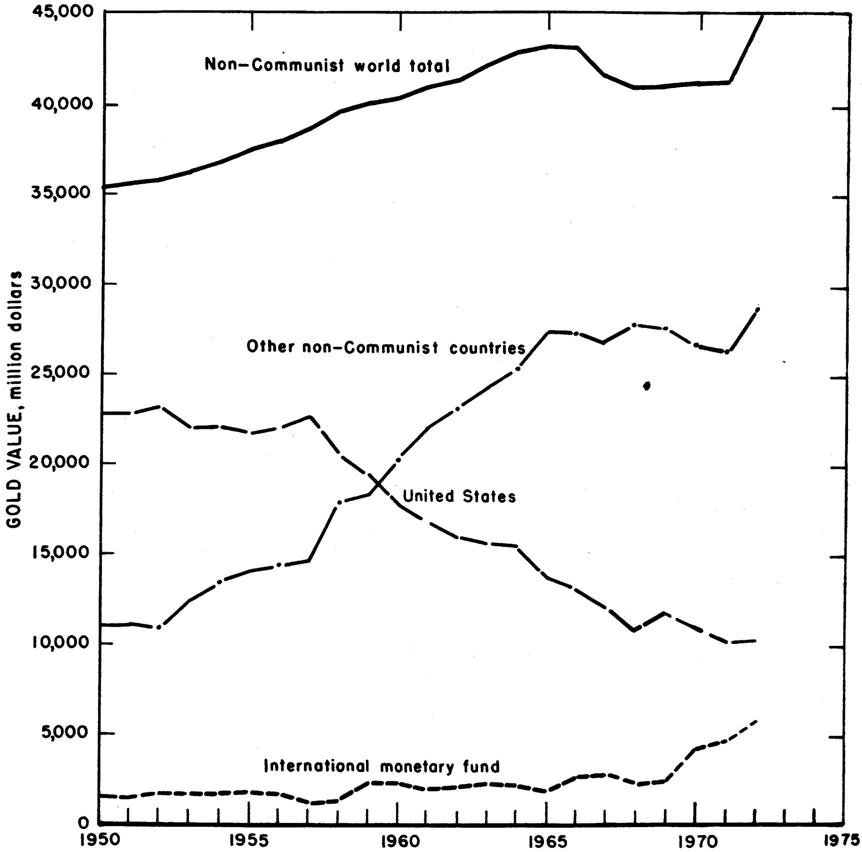

Figure 2.—Gold reserves of free world central banks and governments.

PRICES

Free market gold prices rose to new highs during the year, reaching $70.45 per troy ounce (Engelhard Industries selling price) on August 2. This contrasted sharply with the official U.S. price of gold which was formally increased from $35 to $38 per ounce on May 8, and continued through the balance of the year at that level. The lowest free market price of the year was on January 3, the first trading day when the selling price was $44.45 per ounce. The price on the last trading day, December 28, was $65.10, an increase of $20.65 or 46% for the year. The average price for the year, $58.60 per ounce, was 42% higher than in 1971. High prices generally were attributed to speculative demand due to unsettled monetary and trade problems, also a restricted supply of newly mined gold coming to market.

Table 3.—U.S. monthly gold selling prices, per ounce

(Engelhard Industries)

Month	1972		
	Average	Low	High
January	$46.20	$44.45	$47.80
February	48.70	47.45	49.70
March	48.78	48.50	48.90
April	49.46	48.75	50.20
May	55.09	50.80	59.90
June	62.54	59.65	65.30
July	66.15	65.30	68.75
August	67.49	65.60	70.45
September	65.85	61.70	67.70
October	65.32	64.55	65.95
November	63.36	60.80	64.60
December	64.31	63.35	65.85
Year total	58.60	44.45	70.45

FOREIGN TRADE

Exports of gold in 1972 went largely to Switzerland (40%), the Netherlands (25%), and Canada (16%), with the balance to eight other countries. Scrap comprised 18% of the exports, going to the United Kingdom (45%), Belgium-Luxembourg (40%), and four other countries. A small quantity of monetary gold was included in bullion exports.

Net imports of gold, mostly as bullion, showed a sharp rise (fig. 3) compared with those of 1971 and totaled 4.65 million ounces. The inflow of gold in ore, scrap, and base bullion was balanced by an equal outflow in the form of scrap. Total imports of 6.13 million ounces were valued at $357.7 million; total exports of 1.47 million ounces were valued at $63.1 million. The bulk of the imports came from Canada (49%), Switzerland (33%), and the U.S.S.R. (9%). The balance was from 23 other countries. Virtually all imported gold was destined for industrial use.

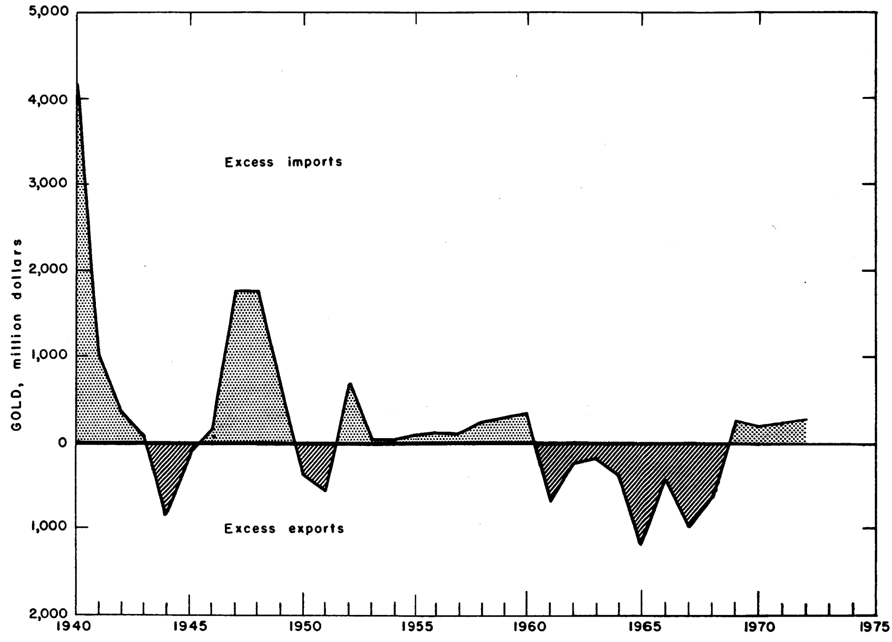

Figure 3.—Net exports or imports of gold.

WORLD REVIEW

World gold production declined again in 1972 to 44.7 million ounces, a drop of 4%. Outputs of most of the main producing countries were lower except in the U.S.S.R. where the Government heavily subsidized production. Policies of the Republic of South Africa limiting the sale of gold continued to exert a dominant influence on the gold markets, although releases of Soviet gold had significant effects in offsetting the shortfall in world supply. World monetary unrest and trade problems resulted in rising speculative demands for gold and higher world prices as supplies fluctuated. Shipments of gold from the Republic of South Africa to the United Kingdom were only about 55% of those in 1971 indicating a diversion to other markets, primarily Switzerland. United Kingdom shipments of gold to the Far East and Middle East were sharply lower showing resistance on the part of purchasers in those areas to high world prices. World industrial consumption was estimated at 4 to 5% higher than in 1971, consonant with the expanding economies of major manufacturing nations.

Argentina.—Corporación Andina S.A., reported discovery of a placer gold deposit near the El Condor mine in Jujuy Province. The company sought assistance to develop the property under claim.

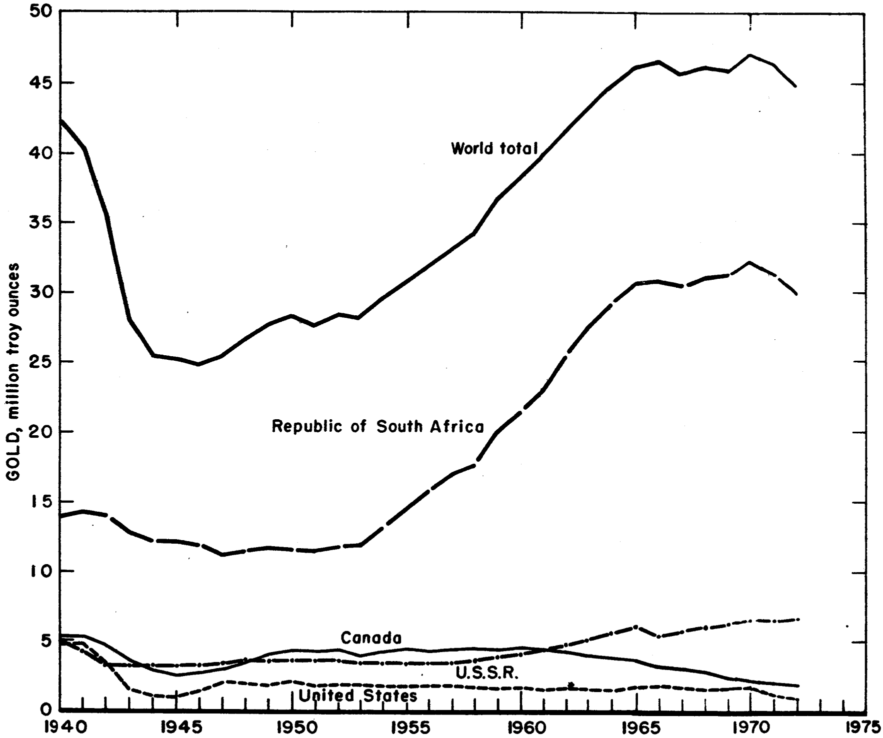

Figure 4.—World production of gold.

Australia.—Australian refinery production of gold from ores and concentrates consisted of 540,300 ounces from domestic and 112,220 ounces from foreign sources. Also, 20,800 ounces was produced from domestic scrap and 2,100 ounces from foreign scrap. Mine production was up 12% compared with that in 1971.

Federal subsidies under the Gold Mining Industry Assistance Act were increased 50% to A$12 maximum per ounce (A$1 = US$1.275); also, producers were allowed to keep 50% instead of 25% of the difference between the free market and official prices of gold. Most Australian and New Guinean gold was marketed. as before, through the 700-member Australian Gold Producers' Association, a cooperative organization of producers. As a result of higher gold prices, additional development work was planned at a number of mines, including the Lake View and Star mines, the largest remaining operations in the Kalgoorlie district of Western Australia. Exploration of a gold-bearing structure was continued near Bathurst, New South Wales, by Pacific Copper Mines Ltd. Gold was reported associated with vanadium in a deposit being explored by Ferrovanadium Corp. at Barambie, east of Geraldton, Western Australia.

Bolivia.—The Bolivian Government issued a Supreme Decree in June 1972 reducing royalties on gold production payable to the Government for the purpose of encouraging gold mining, especially of placer deposits north and northeast of La

Paz.[11] Then, in December the Government issued another Decree annulling the one in June.[12] The new Decree eliminated royalties altogether but applied a 2% tax on gross value of gold production to amortize debts owed by the Gold Cooperatives to the Banco Minero and Bolivian Development Corporation. South American Placers Inc., remained active in Bolivia, selling 11,310 ounces produced in unrefined form in the first half of 1972. Gaensel Gold Mines & Co. completed a shaft to explore placer material on the upper Tipuani River and arranged with Lipez Mining Co. to exploit a placer deposit near the village of Mojotoro. The firm also was expected to take over the placer operation of Condor Mining Co., which had been active since about 1967.

Brazil.—Lode gold production came from one group of mines operated by Mineração Morro Velho S.A. in the area of Nova Lima, Minas Gerais. Output was 5% more than in 1971 when 157,400 ounces was recovered together with silver and white arsenic from 529,218 short tons of ore. Battelle Memorial Institute was preparing plans to modernize the plant, expanding arsenic output and adding sulfur recovery equipment. Cia.Mina da Passagem operated two floating dragline gold washing plants near Mariana, Minas Gerais. About 6,400 ounces was produced in 1971 at this operation. Mineração Tejucana S.A. recovered 2,600 ounces (also 1971) during diamond dredging on the Rio Jequitinhonha, Minas Gerais. A small quantity of byproduct gold was recovered from lead refining at the Panelas smelter, Paraná. A number of small-scale hand and portable washing plant operations in various parts of Brazil supplied the balance of production.[13]

Canada.—Canadian gold production continued its long decline with a 7% drop in 1972. Ontario remained the largest gold producing Province, followed by Quebec, the Northwest Territories, and British Columbia. The greatest drops in production were in Quebec (17%), and Ontario (11%). Significant increases were noted in British Columbia (48%), the Prairie Provinces (49%) and the Atlantic Provinces (100%). Total output was divided approximately, as follows, in percent: Ontario (49); Quebec (27); Northwest Territories (14); British Columbia (6); Prairie Provinces (3); Atlantic Provinces (1); and the Yukon Territory (0.3). In Quebec five gold mines treated 2.4 million tons of ore and shipped products containing 359,469 ounces of gold valued at $13.3 million in 1972. The balance of production was from about 15 base metal mines reporting 12.25 million tons of ore treated and shipments of 181,631 ounces of gold valued at $6.7 million. It was announced about midyear that the Canadian Government would extend its Emergency Gold Mining Assistance Act another 3 years until June 30, 1976. Under the act, gold producers were assured a return of Can $48.27 per troy ounce on mine production.

During the year, Falconbridge Nickel Mines Ltd. announced plans to bring into production a section of its Ellis Lake Opemiska property in the Chibougamau area of Quebec where high copper-gold values were found. A 300-ton-per-day mill addition was planned for treatment, and ore reserves were estimated about 0.5 million tons. Teck Corp. continued the operation of its Lamaque mine in Quebec, which had been scheduled for closure. Also, because of rising gold prices, East Malartic Mines Ltd. was scheduled to remain in operation. Agnico-Eagle Mines Ltd. prepared to open its Eagle gold mine in the Joutel area of Quebec and scheduled startup of a $3.8 million 1,000-ton-per-day mill in 1973. Chibex Ltd. planned to develop a gold-copper property in Rohault Township, in the Southern Chibougamau area. In Ontario, Dickenson Mines Ltd. drifted into some rich gold ore in a section purchased from Robin Red Lake Mines Ltd. and expanded milling to 450 tons per day. Campbell Red Lake Mines Ltd. reported about the same rate of production in early 1972 as the year before with recovery of 0.65 ounce of gold per ton of ore milled. Earnings were sharply higher because of rising gold prices. The firm will spend $1 million to control emissions at its roaster plant in 1973. Pamour Porcupine Mines Ltd. was expanding capacity from 1,900 to 2,500 tons of ore per day in the Porcupine district of Ontario and in November 1972 acquired Aunor

[11] U.S. Embassy, La Paz, Bolivia. State Department Airgram A–155, July 7, 1972, 7 pp.

[12] ———. State Department Airgram A–308, Dec. 8, 1972, 3 pp.

[13] U.S. Embassy, Rio de Janeiro, Brazil. State Department Airgram A–236, Oct. 10, 1972, pp. 19, 20.

Gold Mines Ltd. Pamour milled 346,700 tons of ore grading 0.152 ounce per ton in the first half of 1972. Kennco Explorations Ltd., owned by Kennecott Copper Corp., reported a gold-silver discovery in the Toodoggone River area north of Smithers, British Columbia and held about 600 claims. Other companies were also active in the area.

Colombia.—Pato Consolidated Gold Dredging Ltd., 67.5% owned by International Mining Corp., reported 1971 production of 60,910 fine ounces of gold from 17.8 million cubic yards of gravel. The firm operated four dredges, two of which were moved during the year to new locations. Reserves declined to about 242 million cubic yards averaging 13.1 cents per yard and an additional 167 million yards averaging 10.1 cents per yard (basis $38 per ounce).

Costa Rica.—Financing of a new gold and silver development project was considered by the U.S. Export-Import Bank. The Costa Rican Government continued to require that all gold production be sold to the Central Bank at the official monetary rate.

Dominican Republic.—New York & Honduras Rosario Mining Co. (name changed to Rosario Resources Corp. in 1973) and J. R. Simplot Co., in a joint venture, continued exploration at the Pueblo Viejo gold-silver mine and planned to go into production in late 1974, processing 6,000 tons of oxidized ores per day. At yearend reserves were estimated at about 20 million tons averaging 0.15 ounce of gold and 0.76 ounce of silver. In addition, an equally large underlying sulfide zone was reported to contain 2.19% zinc, 0.25% copper, 0.131 ounce per ton of gold and 1.12 ounces per ton of silver, and a pilot plant was planned for test processing of this ore.

Fiji.—Fiji's gold production, all from the Emperor Gold Mining Co. mine, was sold on the commercial market and in 1971 brought in $3.5 million in foreign exchange. Because of the mine's importance to the local economy, the Government decided to subsidize the operation to the extent of $750,000 for further exploration and development work.

India.—Bharat Gold Mines Ltd. was established to explore and develop the Ramgiri gold field in the Anantapur district of Andhra Pradesh. The Kolar mines in Mysore continued to provide the bulk of Indian gold production under severe problems of depth, heat, and difficult ground control. Most of the balance of production came from the Hutti mines, also in Mysore. Domestic commercial consumption of gold was probably slightly higher than the 48,000 ounces reported in 1971.

Japan.—Domestic consumption of gold during the fiscal year beginning April 1, 1972, was estimated at about 2.8 million ounces. A 13% increase was forecast for the 1973 fiscal year beginning April 1, 1973. Effective on that date, restrictions on importing gold into Japan were to be lifted as a move toward further import liberalization.

Mexico.—Industrias Peñoles, S.A. and affiliates accounted for about 70% of Mexican gold production in 1972. Mexican output was largely byproduct from base metal mining. During 1972, about 32,200 ounces came from gold-silver ores and concentrates; 42,800 ounces came from copper refining, with the balance from other sources, including a small quantity from placer operations. Mid-Continent Mining Corp. (U.S.) announced plans to develop a large gold placer operation in southern Mexico.

New Zealand.—South Westland Minerals Ltd. announced plans to operate two small gold dredges in the Gorge River area of the West Coast where the firm had a 63,000-acre claim. Output of about 12 ounces per day was expected.

Papua–New Guinea, Territory of.—New Guinea Goldfields, Ltd. reported gold bullion sales valued at $485,191 and gold premium receipts at $109,283 in 1971 and values were expected to be higher in 1972. Exploration began on gold leases in Wau under an agreement with C.R.A. Exploration Pty. Ltd. Byproduct gold production began from the copper operation of Bougainville Copper Pty. Ltd. on Bougainville Island. Highland Gold Development NL began construction of a 100-ton-per-day mill at its Kathnel gold deposit near Kainantu, New Guinea.

Peru.—Production included about 34,100 ounces in refined form. About 2,300 ounces of placer gold was produced in 1972. A commission was appointed by the Government of Peru to study and recommend measures to increase Peruvian gold production. Banco Minero reportedly discovered a rich gold placer area on the Inambari River in the Department of Madre de Dios, and small scale production was started. Another gold deposit was under study in the Rioja area of northern Peru. Peru's gold consumption was reportedly about 200,000 ounces annually, more than twice the production.

Philippines.—Production decreased in 1972, mainly because of less byproduct gold output from copper operations. A complex subsidy system remained in effect.[14] Benguet Consolidated Inc. remained the only important lode-gold mining firm in the Philippines, contributing about one-fifth of total gold production.

Rhodesia, Southern.—Efforts were underway to expand gold production with the reactivation of the Shamva mine, once a significant producer. The Dalny mine remained the country's largest gold producer in 1972.

South Africa, Republic of.—Production declined for the second straight year, dropping 7% to 29.2 million ounces in 1972. During the first 9 months of 1972, mines in the Transvaal area produced 14.24 million ounces; 7.85 million ounces was produced in the Orange Free State area. The balance of production came from Cape Province (3,760 ounces) and Natal (965 ounces). The largest and richest gold producer in 1972, as before, was the West Driefontein mine with 2.42 million ounces and mill recovery of 0.96 ounce of gold per metric ton of ore treated. The second largest output was recorded by Vaal Reefs, with 2.12 million ounces produced and recovery grade of 0.40 ounce per ton. Ten other mines produced over 1 million ounces each in 1972.

Generally, during 1972 larger tonnages of lower grade ores were mined because higher gold prices permitted economical production at a lower cutoff grade. Such procedures tend to prolong the productive life of a mine and, in fact, are required by the Republic of South Africa law as a conservation practice. Output from the Rand Refinery Ltd. plant at Germiston, during the company's fiscal year, October 1, 1971, to September 30, 1972, was 30,140,490 fine ounces of gold and 3,295,170 fine ounces of silver. Most of this was from bullion received from the mines, but 98,925 ounces of gold and 473,837 ounces of silver were from scrap. Several mine fires during the year caused production losses and a variety of accidents brought the gold mining fatality rate to about one every 48 hours. Mining costs rose, partly as a result of basic wage increases and devaluation which made imported materials and machinery more expensive. Nearly one-fourth of all production in 1972 went into official reserves of the Republic of South Africa Reserve Bank and, thus, was not available to the free market. The Bank reported gold reserves equivalent to 11.54 million ounces in January, rising to 17.53 million ounces in October (converted at the rate of R28.30 per troy ounce), and accumulation continued through the yearend.

U.S.S.R.—Gold production was higher in 1972, with intensified activities in all producing areas but particularly in the desert areas of Kazakhstan and Uzbekistan, south of the Ural Mountains, and in the region of the Aral Sea. An important new discovery was reported in the Mugodzhar Mountains of western Kazakhstan, and large scale gold production was planned to begin about 1975. Development continued at the Muruntau gold field, on the south slope of the Muruntau Mountains in the central part of western Uzbekistan. A large cyanide/ion exchange extraction plant was in operation and open pit/underground mine development was in progress at Muruntau. Soviet gold sales on world markets rose sharply in 1972 as a result of the need for foreign exchange, principally to purchase wheat.

Venezuela.—Canadian firms, Fairway Explorations and Nor-Acme Gold Mines, sampled a placer gold area in the eastern part of the State of Bolívar and reported relatively high grade assay returns. More extensive sampling was planned in 1972–73. Ores containing disseminated submicroscopic gold from the Callao region of Venezuela were investigated by engineers of the Evaluation Center of the Ministry of Mines, and comparisons were made with Nevada (U.S.) deposits.

TECHNOLOGY

Research to apply cyanide heap-leaching and activated carbon recovery processes to

[14] U.S. Bureau of Mines. Gold: Philippines. Mineral Trade Notes, v. 69, No. 5, May 1972, pp. 11–13.

the treatment of low-grade or "slimy" gold ores has indicated that notable savings in plant investment and operating cost can be made as compared with conventional practice. Bureau of Mines metallurgists at the Salt Lake City Metallurgy Research Center continued work during the year to develop improved gold recovery techniques. Tests at a carbon-in-pulp pilot plant operated in cooperation with the Homestake Mining Co. at Lead, S.Dak., showed that 90% to 95% of the gold in a 0.15-ounce-per-ton slime feed could be cyanide leached and recovered on granular activated carbon. Based on the tests, construction of a full scale plant was started, and the company expected to complete by February 1973, a 2,350-ton-per-day carbon-in-pulp unit which will replace a more costly plate-and-frame filter-type slime-treatment plant. Continued development of a Bureau-invented pressure stripping process for recovering gold from loaded carbon showed that savings could be achieved in stripping time, labor, and reagents. Carbon-column gold extraction methods developed by the Bureau were utilized at the Carlin and Cortez gold operations in Nevada to treat wash solutions before discharge to tailings ponds. Operating data on 4-foot-diameter expanded-bed carbon columns with solutions assaying 0.008 ounce of gold per ton showed recoveries up to 75%, and further testing was in progress to improve on this yield.

Pilot plant studies were conducted at the Bureau of Mines Reno Metallurgy Research Center to improve gold recovery from carbonaceous gold ores using oxidation procedures based on use of chlorine and sodium hypochlorite.[15] Treatment with 20-pounds-per-ton sodium hypochlorite solution at 50° C for 4 hours followed by cyanidation resulted in 90% gold extraction. A chlorine pretreatment produced about the same results in longer time but at lower temperature. Electrolyzing a pulp prepared with a brine solution proved equally effective, with power consumption on the order of 60 kwhr per ton of ore. A patent was issued on the process developed from the work.[16] Also patented were gold extraction processes using malononitrile in place of cyanide for solution followed by collection on an anion-exchange resin[17] and using isopropyl alcohol to recover gold from a chlorinated brine solution followed by precipitation of gold with aqueous sulfur dioxide.[18] Phosphorus took part in a unique method devised to extract gold and other metals from dilute aqueous solutions.[19]

Seismic and other geophysical measurements revealed levels of stratification and boundaries of Tertiary channels containing gold in the Badger Hill area of Nevada County, Calif.[20] It was demonstrated that 30 percent of the drilling expenditures for exploring the deposits could have been saved by using geophysical methods initially. Geochemical surveys showed gold and silver anomalies in three areas of the Brooks Range, Alaska, to accompany base-metal anomalies.[21] One of the areas of interest was an unexplored zone in carbonate rocks north of the Wiseman and Chandalar districts. Placer gold and tin deposits were described in a text accompanying a map of the Teller area of the Seward Peninsula, Alaska.[22] Reworked glacial deposits from Alaska's Seward Peninsula were cited as the source of offshore gold in the northern Bering Sea.[23] Values in one area near Nome were reported as high as 920 ppb ($1.48 per cubic yard at $50 per ounce). Beach deposits on the east shore of Bristol Bay, Alaska, were examined for gold. Although auriferous deposits were occasionally as large as 1 acre in areal extent, they were seldom more than 6 inches thick.

---

15 Scheiner B. J., R. E. Lindstrom, W. J. Guay, and D. G. Peterson. Extraction of Gold From Carbonaceous Ores: Pilot Plant Studies. BuMines RI 7597, 1972, 20 pp.

16. Scheiner, B. J., R. E. Lindstrom, and T. A. Henrie (assigned to U.S. Secretary of the Interior). Recovery of Gold From Carbonaceous Ores. U.S. Pat. 3,639,925, Feb. 8, 1972.

17 Scheiner, B. J. and R. E. Lindstrom (assigned to U.S. Secretary of the Interior). Recovery of Gold. U.S. Pat. 3,635,697, Jan. 18, 1972.

18 Hedrick, C. E., Jr. (assigned to U.S. Atomic Energy Commission). Recovery of Gold By Solvent Extraction. Canadian Pat. 905,683, July 25, 1972.

19 Matthews, D. M. Method and Collector for Extracting Metals From an Aqueous Solution. U.S. Pat. 3,664,829, May 23, 1972.

20 Tibbetts, Benton L., and James H. Scott. Geophysical Measurements of Gold-Bearing Gravels, Nevada County, Calif. BuMines RI 7584, 1972, 32 pp.

21 Brosgé, W. P., and H. N. Reiser. Geochemical Reconnaissance in the Wiseman and Chandalar Districts and Adjacent Region, Southern Brooks Range, Alaska. U.S. Geol. Survey Prof. Paper 709, 1972, 21 pp.

22 Sainsbury, C. L. Geologic Map of the Teller Quandrangle, Western Seward Peninsula, Alaska. U.S. Geol. Survey Map I–685, 1972.

23 Nelson, C. H., and D. M. Hopkins. Sedimentary Processes and Distribution of Particulate Gold in the northern Bering Sea. U.S. Geol. Survey Prof. Paper 689, 1972, 27 pp.

The maximum gold content found was 0.007 ounce per ton.[24]

The distribution of gold in altered bedrock was studied in the Empire Mining district of Colorado, and high positive correlations found with tellurium, tin, bismuth, and silver.[25] Conversely, a negative correlation was found with manganese in the altered material. Based on the study, it was concluded that tellurium was the best "pathfinder" element to use in any widespread reconnaissance exploration for gold. Neutron-activation analyses of a wide variety of igneous rocks and minerals showed that gold in suites of unaltered igneous rocks associated with gold deposits was present in essentially the same amount as in compositionally equivalent rocks from unmineralized regions.[26] Gold content generally was highest in mafic rocks, decreasing in silicic rocks. Gold above background amounts was invariably found only locally in altered rocks, supporting other evidence that concentrations were either the result of remobilization or of secondary introduction. Interestingly, unaltered rhyolitic rocks ranging widely in age, provenance, and petrochemistry were uniformly low in gold (0.1-1 ppb), whereas calc-alkaline rocks from western U.S. batholiths were relatively high (0.5–10 ppb).

Descriptions and references to information on placer gold deposits were published for Arizona [27] and New Mexico.[28] Techniques of scuba diving for placer gold were described in a California publication.[29] Maps were published showing the distribution of gold and silver in several areas of Sierra County, N. Mex.[30] and of gold and copper in the Golconda and Iron Point Quadrangles, Nevada.[31]

A new process was developed for solution mining of gold and silver by introducing into permeable zones containing these metals solutions of chloride brines, with "residual oxidation potentials" over 500 millivolts, recovering the solution, and precipitating the precious metals with hydrogen sulfide.[32] In Yakutsk, U.S.S.R., the Scientific Research Institute for Rare Metals (Irkutsk) conducted field experiments to prevent refreezing of soil, which delays gold mining operations during part of the year.[33] A foam mixture was spread over the soil surface in several layers and mixed with snow to form a porous cover 1.5 meters thick. At the Vaal Reefs gold mine near Klerksdorp, the Republic of South Africa, gold ore, finely ground, was pumped to the surface from a depth of 7,200 feet using a new hydraulic hoisting system. Pumping capacity was equivalent to 25,000 dry tons of ore per month.

The Chamber of Mines of South Africa continued to publish its quarterly series entitled, Gold Bulletin, containing articles on new uses for gold and abstracts on new technology.[34] The January issue reviewed the optical and heat reflecting properties of very thin gold films; the Republic of South Africa research in gold mining and metallurgy was described in the July issue.

Bureau of Mines researchers developed a process including incineration, caustic leaching, smelting, and electrolysis to economically recover precious metals and copper from low-grade, complex electronic scrape.[35] In processing sweated aluminum electronic scrap, researchers developed and

---

24 Kimball, Arthur L. Reconnaissance of Ugashik Beach Sands, Bristol Bay, Alaska. BuMines Open-File Rept. 21–72, 1972, 28 pp.; available for consultation at the Bureau of Mines library in Juneau, Alaska, and at the Central Library, U.S. Department of the Interior, Washington, D.C.; and from the National Technical Information Service, Springfield, Va., PB 211 052.

25 Chaffee, M. A. Distribution and Abundance of Gold and Other Selected Elements in Altered Bedrock, Empire Mining District, Clear Creek County, Colo. U.S. Geol. Survey Bull. 1278C, 1972, 23 pp.

26 Gottfried, David, J. J. Rowe, and R. I. Telling. Distribution of Gold in Igneous Rocks. U.S. Geol. Survey Prof. Paper 727, 1972, 42 pp.

27 Johnson, Maureen G. Placer Gold Deposits of Arizona. U.S. Geol. Survey Bull. 1355, 1972, 103 pp.

28 ———. Placer Gold Deposits of New Mexico. U.S. Geol. Survey Bull. 1348, 1972, 46 pp.

29 Clark, William B. Diving for Gold in California. Calif. Geol., v. 25, No. 6, June 1972, pp. 123–130.

30 Alminas, H. V., K. C. Watts, and D. L. Siems. Maps Showing Silver and Gold Distribution in the Winston and Chise Quandrangles and in the West Part of the Priest Tank Quadrangle, Sierra County, N. Mex. U.S. Geol. Survey MF–400, 1972.

31 Erickson, R. L., and S. P. Marsh. Geochemical, Aeromagnetic, and Generalized Geologic Maps Showing Distribution and Abundance of Gold and Copper, Golconda and Iron Point Quandrangles, Humboldt County, Nev. U.S. Geol, Survey MF–314, 1971 (1972).

32 Stenger, V. A., and W. R. Kramer (assigned to The Dow Chemical Co.). Process for Solution Mining of Silver. U.S. Pat. 3,647,261, Mar. 7, 1972.

33 Engineering and Mining Journal. News Briefs. V. 173, No. 9, September 1972, p. 234.

34 Chamber of Mines of South Africa Research Organization (Johannesburg). Gold Bulletin, v. 5, Nos. 1–4, 1972 issues (quarterly publication).

35 Dannenberg, R. O., J. M. Maurice, and G. M. Potter. Recovery of Precious Metals From Electronic Scrap. BuMines RI 7683, 1972, 19 pp.

Table 4.—Mine production of recoverable gold in the United States, by State

(Troy ounces)

State	1968	1969	1970	1971	1972
Alaska	21,262	21,227	34,776	13,012	8,639
Arizona	95,999	110,878	109,853	94,038	102,996
California	15,682	7,904	4,999	2,966	3,974
Colorado	22,638	25,777	37,114	42,031	61,100
Idaho	3,227	3,403	3,128	3,596	2,884
Montana	13,385	24,189	22,456	15,613	23,725
Nevada	317,382	456,294	480,144	374,878	419,748
New Mexico	6,630	8,952	8,719	10,681	14,897
Oregon	23	875	256	244	(1)
South Dakota	593,052	593,146	578,716	513,427	407,430
Tennessee	140	126	124	192	176
Utah	334,419	433,385	408,029	368,996	362,413
Washington [1]	54,453	47,020	55,008	55,434	41,961
Total	1,478,292	1,733,176	1,743,322	1,495,108	1,449,943

[1] Production of Pennsylvania, Washington, and Wyoming (1969), North Carolina (1971), and Oregon (1972) combined to avoid disclosing individual company confidential data.

Table 5.—Mine production of recoverable gold in the United States, by month

(Troy ounces)

Month	1971	1972
January	133,085	117,605
February	120,977	131,733
March	136,566	139,489
April	127,545	131,660
May	132,514	146,182
June	137,552	131,544
July	84,046	106,504
August	130,127	89,035
September	124,533	107,000
October	122,979	123,382
November	126,218	114,031
December	118,966	111,778
Year total	1,495,108	1,449,943

tested molten-salt electrorefining processes.[36] High quality aluminum was recovered at 94% recovery rates and a copper-gold-silver anode product was treated, achieving recovery rates of 98% of the contained metals.

To develop a better understanding of cyanide reactions in electrodeposition, Bell Telephone Laboratories studied behaviors in various baths using cyclic voltrammentry and galvanostatic transients.[37]

Gold/copper characteristics were the subjects of several investigations, including diffusion of copper through thin gold electroplates,[38] annealing and cold-working properties of Cu_3Au,[39] and the advantages of gold electrodeposited at very low current onto a coarse-grained copper surface for use as a substrate for Permalloy films.[40]

[36] Sullivan, T. A., R. L. de Beauchamp, and E. L. Singleton. Recovery of Aluminum, Base, and Precious Metals from Electronic Scrap. BuMines RI 7617, 1972, 16 pp.

[37] MacArthur, D. M. A Study of Gold Reduction and Oxidation in Aqueous Solutions. J. Electrochem. Sci. and Technol., v. 119, No. 6, June 1972, pp. 672–676.

[38] Pinnel, M. R., and J. E. Bennett. Mass Diffusion in Polycrystalline Copper/Electroplated Gold Planar Couples. Metal. Trans., v. 3, No. 7, July 1972, pp. 1989–1997.

[39] Ward, A. L., and D. E. Mikkola. A Diffraction Study of the Annealing of Cold-Worked Cu_3Au. Metall. Trans., v. 3, No. 6, June 1972, pp. 1479–1485.

[40] Luborsky, F. E., M. W. Breiter, and B. J. Drummond. Characterization of a Gold-Copper Composite Surface for Plated Wire Memory. J. Electrochem. Soc., v. 119, No. 1, January 1972, pp. 92–96.

Table 6.—Twenty-five leading gold-producing mines in the United States in 1972, in order of output

Rank	Mine	County and State	Operator	Source of gold
1	Homestake	Lawrence, S. Dak	Homestake Mining Co	Gold ore.
2	Utah Copper	Salt Lake, Utah	Kennecott Copper Corp	Copper, gold-silver ores.
3	Carlin	Eureka, Nev	Carlin Gold Mining Co	Gold ore.
4	Cortez	Lander, Nev	Cortez Gold Mines	Do.
5	Mayflower	Wasatch, Utah	Hecla Mining Co	Copper-lead ore.
6	Gold Dollar	Ferry, Wash	Knob Hill Mines, Inc	Gold ore.
7	Sunnyside	San Juan, Colo	Standard Metals Corp	Lead-zinc ore.
8	Copper Queen-Lavender Pit	Cochise, Ariz	Phelps Dodge Corp	Copper ore.
9	San Manuel	Pinal, Ariz	Magma Copper Co	Do.
10	New Cornelia	Pima, Ariz	Phelps Dodge Corp	Copper, gold-silver ores.
11	Idarado	Ouray and San Miguel, Colo	Idarado Mining Co	Copper-lead-zinc ore.
12	Ruth Pit	White Pine, Nev	Kennecott Copper Corp	Copper ore.
13	Berkeley Pit	Silver Bow, Mont	The Anaconda Company	Do.
14	Copper Canyon	Lander, Nev	Duval Corp	Do.
15	Morenci	Greenlee, Ariz	Phelps Dodge Corp	Do.
16	Leadville	Lake, Colo	American Smelting & Refining Co	Lead-zinc ore.
17	Magma	Pinal, Ariz	Magma Copper Co	Copper ore.
18	Continental	Grant, N. Mex	UV Industries, Inc	Do.
19	Christmas	Gila, Ariz	Inspiration Consolidated Copper Co	Do.
20	Hogatza River	Yukon River Region, Alaska	UV Industries, Inc	Placer.
21	Tyrone	Grant, N. Mex	Phelps Dodge Corp	Copper ore.
22	Bonney-Misers Chest	Hidalgo, N. Mex	Federal Resources Corp	Do.
23	Center & Penn	Grant, N. Mex	Mt. Royal Mining & Exploration Co	Gold ore.
24	Center	do	The Old Ontario Mining Co	Do.
25	Ruby Claims	Yukon River Region, Alaska	Ruby Mining Co	Placer.

Table 7.—Production of gold in the United States in 1972, 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: Short tons	Lode: Gold ore: Troy ounces of gold	Lode: Gold-silver ore: Short tons	Lode: Gold-silver ore: Troy ounces of gold	Lode: Silver ore: Short tons	Lode: Silver ore: Troy ounces of gold
Alaska	8,639	--	--	--	--	--	--
Arizona	6	--	--	[1] 19,579	[1] 44	W	W
California	2,822	[1] 4,755	[1] 951	W	W	--	--
Colorado	1,345	--	--	--	--	W	W
Idaho	5	--	--	--	--	331,046	1,047
Montana	46	W	W	[1] 6,273	[1] 668	12,480	270
Nevada	24	1,736,568	384,934	--	--	159	19
New Mexico	--	[1] 45,296	[1] 3,379	--	--	W	W
South Dakota	--	1,466,767	407,430	--	--	--	--
Utah	--	--	--	[1] 143,522	[1] 758	W	W
Other States [2]	35	66,461	41,925	--	--	--	--
Total	12,922	3,319,847	838,619	169,374	1,470	343,685	1,336
Percent of total gold	1	--	58	--	(3)	--	(3)

State	Lode: Copper ore: Short tons	Lode: Copper ore: Troy ounces of gold	Lode: Lead ore: Short tons	Lode: Lead ore: Troy ounces of gold	Lode: Zinc ore: Short tons	Lode: Zinc ore: Troy ounces of gold
Alaska	--	--	--	--	--	--
Arizona	138,906,469	102,236	--	--	--	--
California	--	--	--	--	W	W
Colorado	3,730	205	--	--	249,098	600
Idaho	2,375	66	256,605	1,319	--	--
Montana	17,126,668	22,335	119	40	--	--
Nevada	8,511,860	34,771	--	--	--	--
New Mexico	18,767,261	11,351	--	--	--	--
South Dakota	--	--	--	--	--	--
Utah	W	W	--	--	--	--
Other States [2]	--	--	--	--	--	--
Total	183,318,363	170,964	256,724	1,359	249,098	600
Percent of total gold	--	12	--	(3)	--	(3)

State	Lode: Copper-lead, lead-zinc, copper-zinc, and copper-lead-zinc ores: Short tons	Lode: Copper-lead, lead-zinc, copper-zinc, and copper-lead-zinc ores: Troy ounces of gold	Lode: Old tailings, etc.: Short tons	Lode: Old tailings, etc.: Troy ounces of gold	Lode: Total: Short tons	Lode: Total: Troy ounces of gold
Alaska	--	--	--	--	--	8,639
Arizona	96,211	290	83,867	420	139,106,126	102,996
California	[4] 13,187	[4] 75	--	[5] 126	17,942	3,974
Colorado	[6] 922,180	[6] 58,708	7,538	[5] 242	1,182,546	61,100
Idaho	659,886	447	--	--	1,249,912	2,884
Montana	--	--	55,186	366	17,200,726	23,725
Nevada	--	--	--	--	10,248,587	419,748
New Mexico	138,273	167	--	--	18,950,830	14,897
South Dakota	--	--	--	--	1,466,767	407,430
Utah	[4] 35,257,423	[4] 361,655	--	--	35,400,945	362,413
Other States [2]	1,762,000	176	12	1	1,828,473	42,137
Total	38,849,160	421,518	146,603	1,155	226,652,854	1,449,943
Percent of total gold	--	29	--	(3)	--	100

W Withheld to avoid disclosing individual company confidential data.
[1] Combined with other dry and siliceous ores to avoid disclosing individual company confidential data.
[2] Includes Oregon, Tennessee, Washington.
[3] Less than ½ unit.
[4] Combined with other base-metal ores to avoid disclosing individual company confidential data.
[5] Includes byproduct gold recovered from tungsten ore in California and North Carolina and from fluorspar ore in Colorado.
[6] Silver combined with copper-lead-zinc ores to avoid disclosing individual company confidential data.

Table 8.—Gold produced in the United States from ore, old tailings, etc., in 1972, 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	166,029	165,578	--	--	3,296,309	100,386	451	2,604
California	18	15	210	--	5,056	928	3	14
Colorado	1,277	1,269	3,789	--	191,127	55,733	8	233
Idaho	1,394	1,392	--	--	170,319	2,838	2	41
Montana	17,201	17,099	--	--	366,990	22,305	102	1,374
Nevada	[3] 21,336	[3] 21,282	--	384,934	350,804	34,398	54	392
New Mexico	20,236	20,127	--	--	702,000	11,518	109	3,379
South Dakota	1,467	1,467	--	407,430	--	--	--	--
Utah	36,006	35,846	--	--	852,052	361,655	160	758
Other States [4]	5,568	5,568	--	--	278,708	41,917	(5)	185
Total	270,532	269,643	3,999	792,364	6,213,365	631,678	889	8,980

[1] Includes some nongold-bearing ores not separable.
[2] Excludes tonnages of fluorspar and tungsten ores from which gold was recovered as a byproduct.
[3] Includes tonnages from which gold is heap leached.
[4] Includes Oregon, Tennessee, Washington.
[5] Less than ½ unit.

Table 9.—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)		Gold recoverable from all sources (percent)			
	Amalgamation	Cyanidation	Amalgamation	Cyanidation	Smelting [1]	Placers
1968	394,051	482,616	26.7	32.6	38.2	2.5
1969	397,869	580,694	23.0	33.5	42.0	1.5
1970	353,957	638,966	20.3	36.7	40.8	2.2
1971	3,071	832,463	.2	55.7	43.0	1.1
1972	3,999	792,364	.3	54.6	44.2	.9

[1] Crude ores and concentrates.

Table 10.—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:						
1970	1	1	709	29	$1,055	$1.488
1971	2	3	[1] 740	[2] 7	301	[r] [3] .407
1972	2	2	[1] 558	[2] 4	237	.425
Dragline dredging:						
1970	1	3	[1] 2	[2] ([4])	20	[3] 10.000
1971	--	--	--	--	--	--
1972	1	1	([1])	1	27	([3])
Hydraulicking:						
1970	8	4	17	1	20	1.176
1971	5	5	32	1	30	.938
1972	16	16	230	3	180	.783
Nonfloating washing plants:						
1970	19	37	[1] 275	[2] 8	291	[3] 1.058
1971	21	38	[1] 289	[2] 8	[r] 334	[r] [3] 1.156
1972	35	35	[1] 123	[2] 5	281	[r] [3] 2.285
Underground placer, small-scale mechanical and hand methods, and suction dredge:						
1970	9	2	[1] 4	[2] 1	23	[3] 5.750
1971	12	[r] 2	6	[r] ([4])	10	1.667
1972	14	4	2	([4])	6	3.000
Total placers:						
1970	38	47	[1] 1,007	[2] 39	1,409	[3] 1.399
1971	40	[r] 48	[1] 1,067	[2] 16	[r] 675	[r] [3] .632
1972	68	58	[1] 913	[2] 13	731	[3] .801

[r] Revised.
[1] Excludes tonnage of material treated at commercial sand and gravel operations recovering byproduct gold.
[2] Includes gold recovered at commercial sand and gravel operations recovering byproduct gold.
[3] Gold recovered as a byproduct at sand and gravel operations not used in calculating average value per cubic yard.
[4] Less than ½ unit.

Table 11.—U.S. gold consumption in industry and the arts [e]

(Thousand troy ounces)

Industry group	1968	1969	1970	1971	1972
Jewelry and arts	3,908	3,839	3,340	4,299	4,344
Dental	771	710	658	750	750
Industrial, including space and defense	1,925	2,560	1,975	1,884	2,191
Total	6,604	7,109	5,973	6,933	7,285

[e] Estimated by Office of Domestic Gold and Silver Operations, U.S. Treasury Department.

Table 12.—U.S. exports of gold in 1972, by country

Destination	Ore, base bullion and scrap: Troy ounces	Ore, base bullion and scrap: Value (thousands)	Refined bullion: Troy ounces	Refined bullion: Value (thousands)
Belgium-Luxembourg	107,602	$5,969	--	--
Brazil	--	--	322	$14
Canada	1,034	60	232,744	13,314
Germany, West	33,743	2,017	--	--
Japan	2,847	132	--	--
Mexico	--	--	274	17
Netherlands	--	--	372,647	14,161
New Zealand	13	1	--	--
Switzerland	--	--	594,337	20,802
United Kingdom	120,544	6,352	--	--
Venezuela	--	--	6,062	214
Total	265,783	14,531	1,206,386	48,522

Table 13.—U.S. imports (general) of gold in 1972, by country

Country	Ore and base bullion		Refined bullion	
	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)
Australia	38,945	$2,229	--	--
Austria	--	--	24	$1
Canada	22,938	1,239	3,002,858	174,949
Chile	4,440	277	--	--
Colombia	450	27	--	--
France	16	(1)	154,499	8,696
Germany, West	--	--	8	(1)
Honduras	2,017	66	--	--
Jamaica	--	--	99	4
Japan	--	--	7,260	305
Kenya	235	15	--	--
Lebanon	--	--	2,646	114
Mexico	7,743	378	609	26
Nicaragua	19,008	804	--	--
Norway	462	16	--	--
Panama	47	2	--	--
Peru	31,771	1,699	--	--
Philippines	132,600	7,139	--	--
Portugal	64	2	31	2
Singapore	464	16	--	--
South Africa, Republic of	1,507	53	44,914	1,843
Switzerland	--	--	2,033,951	119,132
Taiwan	72	3	--	--
U.S.S.R.	64	2	533,962	34,690
United Kingdom	--	--	79,492	3,885
Venezuela	2,610	56	396	19
Total	265,453	14,023	5,860,749	343,666

[1] Less than ½ unit.

Table 14.—Value of gold imported into and exported from the United States

(Thousand dollars)

Year	Exports	Imports
1970	37,790	237,464
1971	51,249	283,947
1972	63,053	357,689

Table 15.—Gold: World production [1] by country

(Troy ounces)

Country [2]	1970	1971	1972 p
North America:			
Canada	2,408,574	2,243,000	2,079,000
Costa Rica e	500	500	500
El Salvador	2,301	3,503	2,861
Haiti e	3,000	3,000	3,000
Honduras	3,333	3,503	2,021
Mexico	198,241	150,915	146,061
Nicaragua	115,173	121,134	e 120,000
United States	1,743,322	1,495,108	1,449,943
South America:			
Bolivia	30,603	21,541	19,640
Brazil [3]	r 171,331	157,378	165,531
Chile	r 52,177	64,417	75,946
Colombia	r 201,519	188,847	186,816
Ecuador	r 8,521	11,028	e 11,000
French Guiana	2,347	2,315	e 2,300
Guyana	4,433	1,400	4,026
Peru	r 107,673	65,000	82,885
Surinam	1,137	643	e 600
Venezuela	r 22,320	18,567	e 18,834
Europe:			
Finland	20,319	17,489	17,619
France	r 63,112	65,620	e 66,000
Germany, West e	1,000	1,700	1,700
Portugal	11,992	13,696	13,601
Romania e	60,000	60,000	60,000
Sweden	r 44,207	54,528	e 50,000
U.S.S.R. e	6,500,000	6,700,000	6,900,000
Yugoslavia	97,384	123,780	135,033
Africa:			
Angola	--	32	e 30
Cameroon	r 154	88	e 100
Congo (Brazzaville)	r 2,669	2,958	e 3,100
Ethiopia	r 27,295	24,499	20,784
Gabon	16,108	13,728	13,182
Ghana	r 707,900	697,517	724,051
Guinea e	4,000	4,000	4,000
Kenya	--	--	34
Liberia [4]	r 669	2,546	1,324
Mali e	30	30	30
Malagasy Republic	514	412	190
Mozambique	35	19	e 20
Niger	235	119	--
Nigeria	123	40	12
Rhodesia, Southern	500,000	501,551	e 502,000
South Africa, Republic of	32,164,107	31,388,631	29,245,273
Sudan	--	--	95
Tanzania	r 8,263	167	213
Zaire	r 180,590	171,685	81,566
Zambia [5]	e r 10,700	9,866	e 11,400
Asia:			
China, People's Republic of e	50,000	50,000	50,000
India	104,200	118,569	105,773
Indonesia	7,608	10,600	10,899
Japan [6]	r 255,189	255,255	243,027
Khmer, Republic of e	4,000	4,000	4,000
Korea, North e	160,000	160,000	160,000
Korea, Republic of	r 51,345	28,807	17,072
Malaysia:			
Malaya	3,912	4,491	4,788
Sarawak	1,265	1,180	e 1,047
Philippines	602,715	637,048	606,730
Taiwan	22,602	19,496	17,882
Oceania:			
Australia	r 619,922	672,106	754,932
British Solomon Islands Protectorate	291	444	e 400
Fiji	r 106,301	89,129	e 90,000
New Zealand	11,283	9,418	13,511
Papua-New Guinea	[7] 23,798	24,071	409,125
Total	r 47,522,342	46,491,114	44,711,507

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, Czechoslovakia, Spain, and small quantities probably in Argentina, Burma, East Germany, Hungary, Thailand, and several other countries. Data for these countries are not available. Data are also lacking on clandestine activities.

[3] Bullion only; excludes gold from placer operations for which no data are available.

[4] Purchased by Bank of Monrovia.

[5] Contained in blister copper, refinery muds, and electrolytic copper.

[6] Refinery production for Japan was as follows: 1970—709,338 ounces; 1971—772,652 ounces; 1972—845,628 ounces.

[7] New Guinea only.

Graphite

By David G. Willard [1]

Natural graphite remained in tight supply in 1972. Domestic consumption rose, largely as a result of the recovery in the metals industry, while domestic production declined further and production in certain key foreign countries fell. Since imports rose by a lesser amount than estimated consumption, and exports were also higher, a probable drawdown of supplier and consumer stocks was indicated, despite an increase in releases from the national stockpiles. Prices of imported supplies were up sharply, particularly for crystalline graphites, on account of both tightness in the market and devaluation of the dollar. Domestic prices temporarily held the line, but they also rose in early 1973.

The manufactured graphite industry enjoyed a booming year, especially in the second half, again due to the revitalized metals industry market. Demand for electrodes, the industry's staple product which accounts for the bulk of manufactured graphite tonnage, registered a strong increase. Sales of most other manufactured graphite products also exhibited a healthy upswing.

Legislation and Government Programs.—Tight supply markets kept up consumers' interest in disposal of surplus graphite from the national stockpiles. As a result, virtually all surplus graphite in the stockpiles was committed to purchasers in competitive

[1] Economist, Division of Nonmetallic Minerals.

Table 1.—Salient natural graphite statistics

	1968	1969	1970	1971	1972
United States:					
Consumption [1] ..... short tons..	38,507	37,164	32,908	39,172	47,774
Value ..... thousands..	$5,904	$6,354	$5,866	$7,610	$9,836
Exports ..... short tons..	4,169	r 10,264	5,783	5,733	7,289
Value ..... thousands..	$509	$782	$701	$680	$888
Imports for consumption [1] ..... short tons..	67,922	58,459	66,449	57,756	64,135
Value ..... thousands..	$2,494	$2,419	$3,027	$2,727	$3,847
World: Production ..... short tons..	481,793	414,194	433,047	429,905	394,459

r Revised.
[1] Includes some manufactured graphite.

Table 2.—Government yearend stocks of natural graphite

(Short tons)

Type of graphite	National stockpile	Supplemental stockpile	Total all stockpiles
Malagasy crystalline flake:			
Objective	10,800	--	10,800
Uncommitted excess	83	--	83
Total	10,883	--	10,883
Malagasy crystalline fines: Objective	5,230	[1] 1,910	7,140
Ceylon amorphous lump: Objective	[2] 4,295	1,204	5,499
Other than Sri Lanka (formerly Ceylon) and Malagasy, crystalline: Objective	[3] 2,800	--	2,800

[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 1972, Statistical Supplement.

offerings, although actual shipments were scheduled over periods as long as 5 years. Inventories shown in table 2 omit all committed surplus stocks. Comparison with the December 31, 1971 inventory indicates a disposal of 10,363 tons during 1972; however, actual shipments totaled only about 3,000 tons, 45% greater than the 2,100 tons entering the market in 1971.

An administration proposal to reduce the objectives of many stockpiled materials, including graphite, and dispose of the resulting surpluses was under consideration in early 1973.

DOMESTIC PRODUCTION

Production of natural graphite in the United States declined further in 1972, although at a slower rate than the year before. The only operating mine continued to be that of Southwestern Graphite Co. near Burnet, Tex., which produced a small flake crystalline graphite.

Interest in domestic graphite mining was stimulated by the growing shortage and higher prices of imported natural graphite. Several former graphite mines and other properties were being considered for investigation during the year. A deposit in Alaska, estimated to be quite large, was investigated by the Geological Survey. Minor production has occurred there in the past, but its remote location and lack of access as yet render it uneconomic at current prices.

Production of manufactured graphite regained an upward trend in 1972 after slipping slightly the year before. Ouput of 275,311 tons was up 7% from the 256,137 tons produced in 1971. Total value of production increased 17% to $183.6 million from $157.3 million the previous year.

All metallurgical uses of manufactured graphite showed marked improvement as the metals industries recovered from their slump of 1970–71. Most other uses, such as mechanical products made of graphite, also fared well. The outlook for graphite fibers brightened somewhat as the result of its initial commercial acceptance in specialty sporting goods, which represents its first nondefense application.

Manufactured graphite was produced in 26 plants owned by 18 companies during 1972. Some production may have taken place at other locations as well, particularly by users for in-house consumption. The considerably augmented list, as compared to that published last year, includes a number of plants making specialty products such as high-modulus fiber which had not been included in the manufactured graphite survey in previous years. The companies and plant locations were as follows:

Company	*Plant Location*
Airco, Inc., Speer Div	Niagara Falls, N.Y.
	Punxsutawney, Pa.
	St. Marys, Pa.
Avco Corp., Avco Systems Div	Lowell, Mass.
The Carborundum Co., Graphite Products Div	Hickman, Ky.
	Sanborn, N.Y.
Celanese Corp., Celanese Research Lab	Summit, N.J.
Fiber Materials, Inc	Graniteville, Mass.
Great Lakes Carbon Corp	Rosamond, Calif.
	Niagara Falls, N.Y.
	Morganton, N.C.
Hercules, Inc	Magna, 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	No. Hollywood, Calif.
Stackpole Carbon Co	Lowell, Mass.
	St. Mary's, Pa.
Super Temp Co	Santa Fe Springs, Calif.
Ultra Carbon Corp	Bay City, Mich.
Union Carbide Corp	Niagara Falls, N.Y.
	Yabucoa, P.R.
	Columbia, Tenn.
Wickes Engineered Materials	Saginaw, Mich.

CONSUMPTION AND USES

A strong upsurge in consumption of natural graphite in 1972 reflected the increased output of the metal industry. Demand in most refractory uses and other mill and smelter applications was significantly higher than in the two previous years. Consumption was up only a little in other uses of natural graphite.

Table 3 excludes the consumption by numerous small consumers. It is estimated that consumption in 1972, including small consumers, totaled 70,000 tons, a gain of 15% to 20% above the 1971 total. Most of the increase is estimated to have been in refractories and steel mill uses.

Table 3.—Consumption [1] of natural graphite in the United States in 1972, by use

(Short tons)

Use	Crystalline		Amorphous [2]		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
Foundry facings	3,513	$630,356	6,815	$786,702	10,328	$1,417,058
Steelmaking	492	88,713	9,198	1,366,608	9,690	1,455,321
Refractories	1,054	118,070	7,088	693,837	8,142	811,907
Crucibles, retorts, stoppers, sleeves, nozzles	4,174	829,944	639	150,661	4,813	980,605
Lubricants [3]	1,083	610,062	2,353	726,028	3,436	1,336,090
Pencils	1,251	514,805	771	232,072	2,022	746,877
Brake linings	761	349,671	1,042	451,769	1,803	801,440
Batteries	651	268,512	473	240,021	1,124	508,533
Carbon brushes	260	177,139	221	115,876	481	293,015
Bearings	98	57,668	35	26,334	133	84,002
Other mechanical products	114	33,601	92	57,490	206	91,091
Rubber	91	49,713	190	46,105	281	95,818
Powdered metals	195	128,405	85	61,253	280	189,658
Paints and polishes	81	64,632	105	27,211	186	91,843
Other [4]	4,563	795,540	286	136,806	4,849	932,346
Total	18,381	4,716,831	29,393	5,118,773	47,774	9,835,604

[1] Consumption data incomplete. Excludes small consuming firms.
[2] Includes mixtures of natural and manufactured graphite.
[3] Includes ammunition and packings.
[4] Includes antiknock and other compounds, drilling mud, electrical and electronic products, insulation magnetic tape, small packages, and miscellaneous and proprietary uses.

PRICES

Domestic price quotations for natural graphite continued unchanged in 1972, the second successive year of price stability. Price guidelines under Phase II and the availability of substitute materials together held prices in line. Such stability could not be maintained in the face of higher prices for imports and other cost increases, however, and the prices of most graphite rose in early 1973.

Domestic prices, as quoted by the Chemical Marketing Reporter (formerly Oil, Paint, and Drug Reporter), January 1, 1973, on an exwarehouse basis, were as follows:

	Per pound
No. 1 flake graphite, 90% to 95% carbon	$0.32–$0.42
No. 2 flake graphite, 90% to 95% carbon	.239– .32
Powdered crystalline graphite:	
88% to 90% carbon	.184– .27
90% to 92% carbon	.255– .275
95% to 96% carbon	.29– .399
Powdered amorphous graphite	.0626–.195
Powdered amorphous or crystalline graphite, minimum of 97% carbon	.28– .36

Prices of imported crystalline graphite rose during the year, as is shown by the comparison below of yearend prices, f.o.b. sources, quoted in the Engineering and Mining Journal (after conversion from metric tons). Factors causing import prices to go up included higher world demand, smaller production in Sri Lanka (formerly Ceylon), and devaluation of the dollar. Amorphous graphite prices showed no change from the year before.

	Per short ton	
	1971	1972
Flake and crystalline graphite, bags:		
Sri Lanka	$133–$241	$152–$259
Germany, West	143–855	163–929
Malagasy Republic	86–281	122–336
Norway	83–132	91–145
Amorphous, nonflake, cryptocrystalline graphite (80% to 85% carbon):		
Mexico (bulk)	22	22
Korea, Republic of (bags)	22	22

These quotations represent a total range of prices. Actual prices are negotiated between buyer and seller for each individual shipment. A better guide to price trends is the average value per ton, which can be determined from table 5, although it should be kept in mind that these prices are largely for shipments of unprocessed graphite. The average values for the major types of imported graphite in 1972 were as follows:

Crystalline flake, lump, chip, or dust	$160 per ton
Other natural, crude and refined	$ 47 per ton

FOREIGN TRADE

Exports of natural graphite rose sharply in 1972, in contrast to the previous year's small decline. The total of 7,289 tons was 27% greater than the 5,733 tons sold abroad in 1971 and exceeded the shipments in all previous years on record except 1969. Canada remained the best customer, taking 3,523 tons, almost double the amount of the previous year. Sizable increases also occurred in exports to Japan and West Germany.

Imports for consumption were also higher

Table 4.—U.S. exports of natural graphite, by country

Destination	Amorphous, crystalline flake, lump, or chip, and natural, n.e.c.[1]			
	1971		1972	
	Short tons	Value	Short tons	Value
Argentina	28	$3,444	35	$4,737
Australia	201	17,952	174	15,487
Bahamas	69	15,522	--	--
Belgium-Luxembourg	70	9,649	60	8,258
Brazil	135	11,218	85	10,905
Canada	1,902	221,768	3,523	411,872
Chile	15	1,913	30	4,038
Colombia	61	5,591	--	--
Denmark	--	--	11	951
France	202	23,758	169	21,809
Germany, West	256	28,773	454	58,474
India	4	550	--	--
Italy	389	39,707	286	26,933
Jamaica	20	1,289	20	1,905
Japan	249	31,705	539	68,610
Mexico	634	80,926	396	51,692
Netherlands	18	2,340	135	18,618
New Zealand	50	3,180	20	1,450
Norway	--	--	7	840
Panama	--	--	102	14,856
Peru	133	18,963	95	14,150
Philippines	85	13,126	4	511
Portugal	--	--	38	3,988
Singapore	50	6,144	79	6,688
South Africa, Republic of	22	2,118	50	4,390
Spain	206	16,940	--	--
Sweden	58	4,976	6	704
Switzerland	3	675	10	1,636
Taiwan	--	--	10	746
United Kingdom	641	77,914	518	73,549
Venezuela	211	37,346	381	53,533
Other	21	2,150	52	6,960
Total	5,733	679,637	7,289	888,290

[1] Not elsewhere classified.

in 1972, amounting to 64,135 tons which was 11% above the 57,756 tons imported in 1971. The total was the third highest on record, surpassing all years except 1968 and 1970. Crystalline flake graphite imports rose 44% to 7,043 tons, the largest amount since 1956. Imports of other types of graphite increased from 52,874 tons in 1971 to 57,092 tons in 1972, a gain of 8%. Increased demand plus the drop in 1971 imports combined to boost the requirement for foreign supplies to these near record heights.

Table 5.—U.S. imports for consumption of natural and artificial graphite, by country

Year and country	Natural									
	Crystalline flake		Crystalline lump, chip or dust		Other natural crude and refined		Artificial[1]		Total	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1970	5,713	$770	76	$28	60,551	$2,197	109	$32	66,449	$3,027
1971:										
Canada	--	--	--	--	r 4	1	277	19	r 281	20
France	--	--	--	--	28	16	(2)	(2)	28	16
Germany, West	759	228	15	5	823	171	4	3	1,601	407
Italy	--	--	--	--	--	--	27	25	27	25
Japan	--	--	2	3	1	1	2	2	5	6
Korea, Republic of	--	--	--	--	116	6	--	--	116	6
Malagasy Republic	4,063	458	--	--	302	41	--	--	4,365	499
Mexico	(r)--	(r)--	--	--	r 46,182	r 962	--	--	46,182	962
Norway	--	--	--	--	2,830	304	--	--	2,830	304
South Africa, Republic of	--	--	--	--	28	3	--	--	28	3
Sri Lanka (formerly Ceylon)	60	11	56	13	2,159	448	--	--	2,275	472
Switzerland	--	--	--	--	--	--	15	7	15	7
U.S.S.R.	--	--	--	--	3	(2)	--	--	3	(2)
United Kingdom	--	--	--	--	(2)	(2)	--	--	(2)	(2)
Total	r 4,882	r 697	73	21	r 52,476	r 1,953	325	56	r 57,756	2,727
1972:										
Austria	--	--	--	--	16	3	--	--	16	3
Canada	--	--	--	--	7	2	111	7	118	9
China, People's Republic of	--	--	--	--	734	115	--	--	734	115
France	12	4	--	--	--	--	--	--	12	4
Germany, West	828	302	--	--	1,350	288	9	6	2,187	596
Hong Kong	--	--	--	--	5	1	--	--	5	1
Italy	--	--	2	2	--	--	232	26	234	28
Japan	--	--	--	--	--	--	3	7	3	7
Korea, Republic of	--	--	--	--	144	8	--	--	144	8
Malagasy Republic	5,855	784	--	--	446	86	--	--	6,301	870
Malaysia	316	40	--	--	--	--	--	--	316	40
Mexico	--	--	--	--	47,438	1,068	11	7	47,449	1,075
Norway	30	4	119	11	3,419	397	--	--	3,568	412
South Africa, Republic of	--	--	--	--	40	4	--	--	40	4
Sri Lanka (formerly Ceylon)	--	--	--	--	2,810	634	--	--	2,810	634
Switzerland	--	--	--	--	--	--	6	3	6	3
Taiwan	--	--	--	--	99	19	--	--	99	19
Thailand	--	--	--	--	60	15	--	--	60	15
U.S.S.R.	--	--	--	--	31	3	--	--	31	3
United Kingdom	2	1	--	--	--	--	--	--	2	1
Total	7,043	1,135	121	13	56,599	2,643	372	56	64,135	3,847

r Revised.
1 Includes only that received in raw material form; excludes products made of graphite.
2 Less than ½ unit.

WORLD REVIEW

World production of graphite decreased in 1972. The downswing, coupled with a probable rise in world demand, further aggravated the supply problem. Supplies of premium grades remained especially tight. A decline in exports by Sri Lanka (formerly Ceylon), stemming from the adjustment problems of their newly nationalized industry, was a primary cause of the supply shortage, and an increase in the demand for high-purity graphite in electronic and other specialized uses added to the imbalance. The large decline in output of low-grade material in the Republic of Korea was less serious in nature. Rising production of metals increased the demand for other grades, but supplies were adequate to meet the needs.

Brazil.—Graphite deposits were discovered near Niteroi in the vicinity of Rio de Janeiro. [2]

Malagasy Republic.—Riots brought about the fall of the Tsiranana Government in May, and it was replaced by a military administration under General Ramanantsoa. Amid conflicting political pressures the new government has maintained the existing private enterprise system but has not clearly indicated its future economic policies. The resulting uncertainty created apprehension about the future supply of Malagasy graphite, but at yearend appeared to have had little adverse effect on production.[3]

Riots closed the port of Tamatave, outlet for all of the country's graphite exports, during part of the month of December. Potential further disturbances caused ocean shipping companies to avoid Tamatave for a period thereafter, following which ships would dock at the port only on payment of a 20% surcharge. As a result, graphite shipments were greatly delayed.[4]

Sri Lanka (formerly Ceylon).—Adjustment problems resulting from takeover of the graphite mines by the State Graphite Corporation caused production to drop in 1972. However, a renewed interest in prospecting was shown by the increased activity of the Geological Survey. Geophysical investigations and drilling were carried out near Bogala, the country's largest graphite mine, and at two other locations in the southwestern part of the island.[5]

The export duty on graphite, which had been raised to 50% in 1970, was reduced back to 25% in January 1972. However, no comparable reduction in prices occurred.[6]

Yugoslavia.—A deposit estimated to contain 11 million short tons of high-grade graphite ore was discovered near Razanj in Serbia. Plans were announced to begin exploiting the deposit in 1973.[7]

[2] Industrial Minerals. Companies and Minerals. No. 58, July 1972, p. 38.
[3] U.S. Embassy, Tananarive, Malagasy Republic. State Department Airgram A-129, Oct. 17, 1972, pp. 9–13; and conversations with members of the U.S. graphite industry.
[4] Joint Publications Research Service. Translations on Africa No. 1279. JPRS 58460, Mar. 13, 1973, p. 16.
[5] World Mining. V. 8, No. 7, June 25, 1972, p. 115.
[6] Industrial Minerals. Graphite: Nationalization Still Rankles. No. 55, April 1972, p. 28.
[7] Engineering and Mining Journal. Exploration Round-up. V. 173, No. 3, March 1972, p. 272.

Table 6.—Graphite: World production by country

(Short tons)

Country [1]	1970	1971	1972 [p]
Argentina	84	162	[e] 165
Austria	30,570	23,581	20,701
Brazil	[e] 2,800	3,057	3,458
Burma	86	168	239
China, People's Republic of [e]	33,000	33,000	33,000
Germany, West	18,084	[2] 13,986	[e] 14,000
Italy	2,302	701	852
Japan	1,615	1,162	940
Korea, North [e]	83,000	83,000	83,000
Korea, Republic of	65,621	79,934	44,939
Malagasy Republic	21,903	22,074	[e] 20,012
Mexico	61,341	56,125	60,748
Norway	11,447	9,172	[e] 9,000
Romania	6,635	[e] 6,600	[e] 6,600
Sri Lanka (formerly Ceylon)	[3] 10,788	7,921	7,871
South Africa, Republic of	771	1,262	934
U.S.S.R. [e]	83,000	88,000	88,000
United States	W	W	W
Total	[r] 433,047	[r] 429,905	394,459

[e] Estimate. [p] Preliminary. [r] Revised. W Withheld to avoid disclosing individual company confidential data.
[1] In addition to countries listed, Czechoslovakia, India, Southern Rhodesia, and the Territory of South-West Africa produce graphite, but available information is inadequate to make reliable estimates of output levels.
[2] In part produced from imported crude graphite.
[3] Exports.

Other Countries.—Studies of known graphite deposits with a view to future development or expansion were announced in India, Italy, and Mozambique.[8]

TECHNOLOGY

As in previous years, technological developments during 1972 centered on uses of manufactured graphite, particularly composite materials containing graphite fibers. But some advances affecting the use of natural graphite also occurred.

A study carried out in India demonstrated that column flotation can result in a higher percent recovery than conventional flotation methods because it reduces entrapment of gangue in the mineral during agitation.[9]

Research into the possibility of a reaction affecting graphite in contact with aluminum metal indicated that an oxide layer on the aluminum normally prevents the metal from wetting graphite, but the presence of cryolite can provide a flux which permits a reaction to occur.[10]

Significant growth is anticipated for the powdered metals industry. Graphite is the source of carbon in many powdered metal mixes. One important gain was the announcement that future rotary engines in General Motors cars will have powdered metal rotors.[11]

The majority of manufactured graphite research continued to be applied to the development of composite materials using graphite fiber. Efforts to combine the fibers with metal matrixes, which would be stronger than graphite/plastics composites, concentrated on alumina and aluminum. Initial research on one such composite was carried out by the National Aeronautics and Space Administration (NASA) at the Marshall Space Flight Center.[12] Other programs have been directed toward combining the high-cost graphite fibers with lower cost glass fibers in order to produce a composite material at a lower overall cost.[13]

In another area of use, development of a nickel-coated graphite anode for the electrolysis of chloride salts eliminated contamination of the product which previously resulted from disintegration of uncoated anodes.[14]

Patents incorporating graphite covered a wide spectrum of uses in 1972. Two included graphite in lubricating compounds and one patent each made use of it in coatings, cleaning compounds, pigments, packings, and washers. A screening mechanism was developed for use with either graphite or mica.

---

[8] U.S. Embassy, Rome, Italy. State Department Airgram A-653, Oct. 17, 1972, p. 7.
Sahu, K. C., and A. D. Mungee. Origin and Beneficiation of Low Grade Graphite from Sagtala in Panchmahal District, Gujarat. J. Mines, Metals and Fuels, v. 20, No. 3, March 1972, pp. 75–78.
U.S. Embassy, Lourenço Marques, Mozambique. State Department Airgram A-102, July 7, 1972, Enc. 1, p. 10.

[9] Narasimhan, K. S., S. B. Rao, and G. S. Chowdhury. Column Flotation Improves Graphite Recovery. Eng. and Min. J., v. 173, No. 5, May 1972, pp. 84–85.

[10] Dorward, K.C. Reaction Between Aluminum and Graphite in the Presence of Cryolite. Metallurgical Trans., v. 4, No. 1, January 1973, p. 386.

[11] American Metal Market. The Melting Pot. V. 79, No. 212, Nov. 20, 1972, p. 6.

[12] Materials Engineering. Materials Outlook. V. 76, No. 3, September 1972, p. 13.

[13] Materials Engineering. What's New in Reinforced Plastics. V. 75, No. 3, March 1972, p. 46.

[14] Journal of Mines, Metals and Fuels. Plants, Equipment and Practice. V. 20, No. 4, April 1972, p. 124.

Gypsum

By Avery H. Reed [1]

The gypsum industry operated at record levels in 1972. Output of crude and calcined gypsum set new annual records. Imports of crude gypsum were an alltime high. Sales of gypsum products were higher than for any other year.

Republic Gypsum Co. reopened the Rosario mine and plant in Santa Fe County, N. Mex., and Temple Gypsum Co. completed its new processing plant at West Memphis, Ark.

The gypsum resources of Oklahoma were described.[2]

Many companies were concerned about environmental problems at gypsum plants. Rigid air pollution standards could force extensive plant revisions. The disposal and possible use problems of waste gypsum at fertilizer plants were examined.

Table 1.—Salient gypsum statistics
(Thousand short tons and thousand dollars)

	1968	1969	1970	1971	1972
United States:					
Active mines and plants [1]	115	114	108	107	108
Crude:[2]					
Mined	10,018	9,905	9,436	10,418	12,328
Value	36,775	38,354	35,132	39,057	48,504
Imports for consumption	5,474	5,858	6,128	6,094	7,718
Calcined: Produced	8,844	9,324	8,449	9,526	12,005
Value	133,239	143,466	132,047	151,991	195,862
Products sold (value)	404,739	414,880	353,474	435,257	560,569
Exports (value)	3,556	3,446	3,475	4,214	5,276
Imports for consumption (value)	13,058	14,602	16,581	16,332	22,042
World: Production	54,486	57,581	56,868	58,552	63,545

[1] Each mine, calcining plant, or combination mine and plant is counted as 1 establishment.
[2] Excludes byproduct gypsum.

DOMESTIC PRODUCTION

Thirty-six companies mined crude gypsum at 65 mines in 21 States. Of these mines, 12 were underground and 53 were open pit. Output increased 18% to 12,328,000 tons, 13% above the 1959 record. Leading States were Michigan, Texas, California, Iowa, and Oklahoma. These five States, with 30 mines, accounted for 59% of the total crude gypsum. Leading companies were United States Gypsum Co. (13 mines), National Gypsum Co. (7 mines), Georgia-Pacific Corp. (7 mines), The Flintkote Co. (2 mines), and The Celotex Co. (3 mines). These five companies, operating 32 mines, produced 75% of the total crude gypsum. Leading mines were U.S. Gypsum's Plaster City, Calif., mine, and Alabaster, Mich., mine; National's Tawas City, Mich., mine, and Shoals, Ind., underground mine; and U.S. Gypsum's Southard, Okla. mine.

Fourteen companies calcined gypsum at

[1] Physical scientist, Division of Nonmetallic Minerals.
[2] Johnson, Kenneth S. Gypsum and Salt Resources in Oklahoma. Industrial Minerals, v. 62, November 1972, pp. 33–39.

Table 2.—Gypsum production in the United States, 1880–1972

(Thousand short tons and thousand dollars)

Year	Production				Products sold or used							
	Crude		Calcined		Uncalcined		Calcined				Prefabricated products	Total
							Industrial		Building			
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Value	Value
1880	90	400	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1881	85	350	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1882	100	450	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1883	90	420	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1884	90	390	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1885	90	405	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1886	95	429	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1887	95	425	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1888	110	550	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1889	268	764	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1890	183	575	NA	NA	79	412	57	143	19	19	NA	574
1891	208	628	NA	NA	110	482	52	117	19	29	NA	628
1892	256	695	NA	NA	106	508	48	106	58	81	NA	695
1893	254	697	NA	NA	123	518	50	106	43	72	NA	696
1894	239	762	NA	NA	127	610	42	96	35	56	NA	762
1895	265	797	NA	NA	151	674	35	85	27	38	NA	797
1896	224	573	NA	NA	138	494	27	60	17	19	NA	573
1897	289	756	NA	NA	181	662	32	67	23	27	NA	756
1898	292	755	NA	NA	190	657	41	91	6	7	NA	755
1899	486	1,287	NA	NA	286	1,120	50	101	58	67	NA	1,288
1900	594	1,627	NA	NA	400	1,500	46	83	35	44	NA	1,627
1901	634	1,507	NA	NA	400	1,325	59	110	69	72	NA	1,507
1902	816	2,089	NA	NA	539	1,889	61	106	81	93	NA	2,088
1903	1,042	3,793	NA	NA	743	3,550	75	155	74	88	NA	3,793
1904	941	2,784	NA	NA	665	2,581	70	142	56	61	NA	2,784
1905	1,043	3,029	NA	NA	737	2,849	40	74	67	106	NA	3,029
1906	1,541	3,838	NA	NA	900	3,220	63	157	187	461	NA	3,838
1907	1,752	4,942	NA	NA	1,125	4,402	47	116	233	424	NA	4,942
1908	1,722	4,076	NA	NA	1,126	3,650	38	92	209	334	NA	4,076
1909	2,253	5,907	NA	NA	1,514	5,354	50	104	292	449	NA	5,907
1910	2,379	6,523	NA	NA	1,584	5,854	54	110	368	559	NA	6,523
1911	2,324	6,462	NA	NA	387	589	1,557	5,759	42	114	NA	6,462
1912	2,501	6,564	NA	NA	442	624	1,703	5,859	29	82	NA	6,565
1913	2,599	6,775	NA	NA	463	697	1,691	5,881	83	197	NA	6,775
1914	2,476	6,896	NA	NA	444	647	1,566	6,039	85	210	NA	6,896
1915	2,448	6,597	NA	NA	476	651	1,532	5,803	82	143	NA	6,597
1916	2,758	7,959	NA	NA	547	790	1,689	6,914	117	255	NA	7,959
1917	2,696	11,116	NA	NA	624	1,124	1,545	8,949	132	1,046	NA	11,117
1918	2,057	11,471	NA	NA	470	1,237	1,188	8,569	140	1,666	NA	11,472
1919	2,420	15,728	NA	NA	510	1,518	1,408	11,906	188	2,304	NA	15,728

See footnote at end of table.

1920	3,129	24,533	NA	NA	669	2,565	1,594	15,849	310	6,119	NA	24,534
1921	2,891	23,700	NA	NA	720	2,266	46	505	1,751	20,930	NA	23,713
1922	3,780	29,361	NA	NA	771	2,443	126	1,199	2,365	25,719	NA	29,368
1923	4,753	34,888	NA	NA	847	2,577	177	1,749	2,925	30,562	NA	34,881
1924	5,043	42,724	NA	NA	982	2,674	213	1,917	3,356	38,133	NA	42,721
1925	5,678	47,577	NA	NA	1,014	2,823	207	2,037	3,890	42,717	NA	47,577
1926	5,635	46,721	NA	NA	961	2,510	221	2,130	3,795	42,082	NA	46,722
1927	5,347	42,174	NA	NA	965	2,389	233	2,350	3,679	37,436	NA	42,175
1928	5,102	32,036	NA	NA	999	1,902	194	1,151	3,447	28,984	10,538	42,575
1929	5,016	31,293	NA	NA	1,066	2,097	237	1,612	3,125	27,584	9,707	41,000
1930	3,471	27,051	NA	NA	990	1,886	167	1,242	2,025	23,924	10,798	37,850
1931	2,559	20,801	NA	NA	876	2,020	79	633	1,457	13,176	14,046	29,875
1932	1,416	12,906	NA	NA	516	1,216	61	573	827	7,907	8,704	18,400
1933	1,335	11,927	NA	NA	491	1,089	65	585	720	7,031	7,520	16,225
1934	1,536	13,762	NA	NA	579	1,267	77	770	766	7,878	8,085	18,000
1935	1,904	18,860	1,383	8,000	595	1,329	104	979	1,043	10,902	11,415	24,625
1936	2,713	26,222	1,900	10,000	831	1,866	119	1,141	1,431	14,360	16,958	34,325
1937	3,058	4,783	2,411	11,076	861	1,921	126	1,363	1,669	16,010	19,506	38,800
1938	2,684	4,272	2,253	10,990	757	1,681	94	1,155	1,485	13,910	19,510	36,256
1939	3,227	4,431	2,881	14,621	868	1,927	110	1,374	1,780	17,090	25,537	45,928
1940	3,699	5,228	3,308	17,255	929	2,251	124	1,533	1,863	17,329	32,380	53,493
1941	4,789	6,794	3,981	19,747	1,321	3,139	152	1,885	1,939	18,053	46,681	69,758
1942	4,698	6,811	3,045	16,403	1,515	3,534	143	1,841	1,157	11,084	46,713	63,172
1943	3,878	5,960	2,558	14,752	1,234	3,115	163	2,259	769	7,316	46,407	59,097
1944	3,761	6,451	2,363	13,841	1,056	2,954	200	2,551	754	7,339	42,857	55,701
1945	3,812	6,984	2,485	14,474	1,148	3,433	158	2,326	880	9,087	45,308	60,149
1946	5,629	12,442	4,170	29,273	1,641	5,106	207	3,161	1,938	22,049	66,879	97,195
1947	6,208	16,530	5,011	38,726	1,950	7,012	207	3,430	2,203	26,096	91,877	128,415
1948	7,255	19,113	6,243	48,145	2,226	7,927	219	3,731	2,541	31,984	133,191	176,833
1949	6,608	18,319	5,767	45,455	1,990	7,127	212	3,562	2,324	29,949	118,108	158,746
1950	8,193	22,735	7,341	60,480	2,218	7,912	266	4,530	2,942	39,576	154,158	206,176
1951	8,666	24,024	7,455	65,761	2,530	9,413	289	5,468	2,838	43,531	177,423	235,835
1952	8,415	22,896	6,874	59,696	2,706	9,617	252	5,000	2,551	39,016	171,291	224,924
1953	8,293	23,175	7,166	66,669	2,656	9,844	254	5,261	2,581	41,785	188,163	245,053
1954	8,996	27,384	7,618	76,171	2,746	10,592	250	5,384	2,694	45,355	210,822	272,153
1955	10,684	33,938	8,848	88,576	2,938	11,436	299	6,337	3,038	52,846	248,705	319,324
1956	10,316	34,099	8,608	91,336	3,259	13,173	334	7,309	2,894	54,078	247,091	321,651
1957	9,195	29,871	7,801	83,455	3,139	13,120	319	6,998	2,718	51,349	229,628	301,095
1958	9,600	32,495	8,122	91,402	3,471	14,018	250	5,850	2,518	49,584	259,618	329,070
1959	10,900	39,231	9,268	111,740	3,989	16,109	311	7,087	2,682	53,928	311,211	388,335
1960	9,825	35,690	8,591	120,984	3,716	15,486	284	6,362	2,393	48,574	290,768	361,190
1961	9,500	34,996	8,246	118,145	3,899	16,161	258	6,328	2,079	42,123	294,199	358,811
1962	9,969	36,343	8,819	127,436	4,049	17,097	269	6,745	2,055	41,054	327,404	393,300
1963	10,388	38,138	9,181	131,668	4,209	17,865	279	7,094	2,026	41,104	348,027	414,090
1964	10,684	38,874	9,440	135,877	4,562	19,138	292	7,508	1,965	41,187	363,884	431,717
1965	10,033	37,375	9,320	133,028	4,577	20,313	319	8,281	1,805	37,784	353,242	419,620
1966	9,647	35,681	8,434	119,747	4,693	21,444	322	8,939	1,579	33,985	312,503	376,871
1967	9,393	34,383	7,879	115,467	4,511	20,882	293	8,288	1,373	30,468	302,630	362,268
1968	10,018	36,775	8,844	133,239	4,935	23,145	301	8,914	1,314	30,007	372,680	404,739
1969	9,905	38,354	9,324	143,466	4,681	22,048	316	8,769	1,176	28,685	384,068	414,880
1970	9,436	35,132	8,449	132,047	4,258	21,294	284	9,058	1,000	25,470	323,122	353,474
1971	10,418	39,057	9,526	151,991	4,624	22,888	268	8,843	916	24,438	379,088	435,257
1972	12,328	48,504	12,005	195,862	5,195	26,911	299	10,657	841	25,258	497,744	560,569

NA Not available.

76 plants in 30 States. Output increased 26% to 12,005,000 tons and set a new annual record. Leading States were Texas, California, New York, Iowa, and Georgia. These five States, with 29 plants, accounted for 43% of the total calcined gypsum. Leading companies were United States Gypsum Co. (23 plants), National Gypsum Co. (19 plants), Georgia-Pacific Corp. (10 plants), The Flintkote Co. (5 plants), and Kaiser Gypsum Co. Inc. (5 plants). These five companies operated 62 plants, and produced 85% of the total calcined gypsum.

Valley Nitrogen Producers Inc., Occidental Petroleum Corp., and Collier Carbon & Chemical Corp. sold 278,600 tons of byproduct gypsum for agricultural use in California.

The United States is the world's leading producer of gypsum, accounting for 19% of the total output.

Table 3.—Crude gypsum mined in the United States, by State
(Thousand short tons and thousand dollars)

State	1971			1972		
	Active Mines	Quantity	Value	Active Mines	Quantity	Value
California	7	1,352	3,884	5	1,525	4,965
Iowa	5	1,154	4,460	5	1,380	5,714
Michigan	5	1,433	5,585	5	1,650	7,267
Nevada	3	695	2,372	3	860	2,871
New York	3	415	2,376	3	486	3,079
Oklahoma	8	1,022	3,073	8	1,196	3,888
South Dakota	1	21	83	1	24	43
Texas	7	1,303	4,806	7	1,542	5,284
Washington	1	W	W	1	5	13
Wyoming	4	232	918	3	W	W
Other States [1]	23	2,791	11,500	24	3,660	15,380
Total	67	10,418	39,057	65	12,328	48,504

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes Louisiana, Montana, and Virginia, 1 mine each; Arkansas, Indiana, Kansas, Ohio, and Utah, 2 mines each; New Mexico, (1972) 3 mines; Arizona and Colorado, 4 mines each.

Table 4.—Calcined gypsum produced in the United States, by State
(Thousand short tons and thousand dollars)

State	1971					1972				
	Active plants	Quantity	Value	Calcining equipment: Kettles	Calcining equipment: Other [1]	Active plants	Quantity	Value	Calcining equipment: Kettles	Calcining equipment: Other [1]
California	6	881	10,838	18	5	7	1,154	12,036	16	9
Florida	3	518	5,769	9	2	3	594	7,014	9	2
Georgia	3	616	11,058	15	--	3	702	12,984	15	--
Iowa	5	796	13,704	22	4	5	913	15,396	22	4
Michigan	4	373	7,263	9	1	4	536	10,640	9	1
Nevada	3	330	4,851	12	6	3	562	8,386	12	6
New Jersey	4	452	7,369	9	4	4	529	9,798	9	4
New York	7	922	15,688	21	8	7	1,138	21,214	21	6
Ohio	3	358	5,790	9	1	3	433	6,796	9	1
Texas	7	1,035	17,074	30	1	7	1,294	21,538	30	3
Other States [2]	29	3,245	52,587	77	37	30	4,150	70,060	78	52
Total	74	9,526	151,991	231	69	76	12,005	195,862	230	88

[1] Includes rotary and beehive kilns, Holoflites, grinding-calcining units, and Hydrocal cylinders.
[2] Includes Arizona, Arkansas, Colorado, Connecticut, Delaware, Illinois, Massachusetts, Montana, New Hampshire, New Mexico (1971), Pennsylvania, and Washington, 1 plant each; Kansas, Louisiana, Maryland, New Mexico (1972), Oklahoma, Utah, Virginia, and Wyoming, 2 plants each; and Indiana, 3 plants.

CONSUMPTION AND USES

Apparent consumption of gypsum, as measured by production plus imports minus exports, was 20.0 million tons, an increase of 21% and a new annual record. Imports were 39% of the total.

Of the total gypsum supply, 5.2 million

tons, or 26%, was sold or used uncalcined. Of the total uncalcined gypsum, 3.9 million tons, or 76%, was sold or used in portland cement, and 1.1 million tons, or 22%, was used in agriculture. In addition, 279,000 tons of byproduct gypsum was sold for agricultural uses.

The leading consuming sales regions for gypsum in portland cement were the Middle Atlantic and the West South Central, which accounted for 51% of the total. For agricultural gypsum, the Pacifc sales region accounted for 96% of the total. It has been estimated that the alkali soils of the Western States could benefit by as much as 12 tons of gypsum per acre.

Of the total calcined gypsum, 92% was used for prefabricated products and 8% was used for plasters. Of the prefabricated products, 76% was regular wallboard, 15% was type-X wallboard, and 3% was lath.

The leading consuming sales regions for prefabricated products were the South Atlantic and the East North Central, which together accounted for 35% of the total. For plaster, the East North Central and the South Atlantic accounted for 45% of the total.

PRICES

The value of crude gypsum increased from $3.75 per ton in 1971 to $3.93. The value of calcined gypsum increased from $15.96 in 1971 to $16.32 per ton. The average value of byproduct gypsum sold was $5.11 per ton.

The average value of gypsum products increased from $25.73 in 1971 to $28.88 per ton. Prefabricated products were valued at $38.06, plasters at $31.53, and uncalcined products at $5.18 per ton.

Quoted prices for gypsum are published monthly in the Engineering News-Record. Prices quoted December 21, 1972, showed a wide range, based on delivered prices. Regular ½-inch wallboard prices ranged from $42 per thousand square feet at Dallas to $85 at Chicago. Prices for plaster ranged from $31 per ton at Dallas to $58 per ton at Minneapolis.

Table 5.—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	1971		1972	
	Quantity	Value	Quantity	Value
Uncalcined:				
Portland cement	3,386	16,173	3,924	19,405
Agriculture	1,124	5,386	1,146	5,970
Other	113	1,328	124	1,535
Total [1]	4,624	22,888	5,195	26,911
Calcined:				
Industrial plaster	263	8,843	299	10,657
Building plaster:				
Regular base coat	381	8,086	329	7,910
Mill-mixed base coat	188	5,639	178	5,707
Veneer plaster	90	5,034	98	5,713
Other [2]	257	5,679	235	5,928
Total [1]	916	24,438	841	25,258
Prefabricated products [3]	11,112	379,088	13,078	497,744
Total calcined	12,291	412,369	14,217	533,658
Grand total	16,915	435,257	19,412	560,569

[1] Data may not add to totals shown because of independent rounding.
[2] Includes gauging, molding, and Keene's cement, roof deck concrete, and other uses.
[3] Includes weight of paper, metal, or other materials.

Table 6.—Prefabricated products sold or used in the United States, by product

Product	1971 Quantity (thousand square feet)	1971 Quantity (thousand short tons)[1]	1971 Value (thousands)	1972 Quantity (thousand square feet)	1972 Quantity (thousand short tons)[1]	1972 Value (thousands)
Lath:						
3/8 inch	361,312	279	$9,286	430,536	335	$12,792
1/2 inch[2]	111,918	102	3,314	18,004	17	596
Total[3]	473,231	381	12,600	448,540	352	13,388
Veneer base	291,754	278	8,858	357,443	316	13,521
Sheathing	274,212	260	8,215	337,084	319	12,024
Regular gypsumboard:						
1/4 inch	105,698	59	2,708	104,444	66	2,860
3/8 inch	1,200,682	851	35,659	1,196,096	913	36,982
1/2 inch	6,858,222	6,207	189,692	9,083,662	8,291	291,961
5/8 inch	916,469	1,078	34,342	612,518	608	26,847
1 inch[4]	27,336	48	2,016	50,977	80	3,778
Total[3]	9,108,408	8,244	264,417	11,047,698	9,958	362,428
Type-X gypsumboard	1,616,790	1,826	67,226	1,783,677	1,939	75,466
Predecorated wallboard	123,048	120	17,660	195,360	178	19,274
Other	2,480	3	112	14,254	14	1,641
Grand total[3]	11,889,927	11,112	379,088	14,184,059	13,078	497,744

[1] Includes weight of paper, metal, or other material.
[2] Includes a small quantity of other unspecified lath.
[3] Data may not add to totals shown because of independent rounding.
[4] Includes a small quantity of 5/16-inch, 5/8-inch firetardboard, and 3/4-inch gypsumboard.

FOREIGN TRADE

Imports of crude gypsum were 7.7 million tons, of which 77% came from Canada, 16% from Mexico, and 6% from Jamaica. Exports of crude gypsum totaled 51,000 tons.

Although there are vast deposits of gypsum in the United States, there are no known deposits along the coastlines. There are large tidewater deposits in Canada and Mexico from which shipments may be made to coastal cities at a lower delivered price than domestic gypsum.

Table 7.—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
1970	41	1,915	1,560	3,475
1971	r 49	2,318	1,896	4,214
1972	51	2,582	2,694	5,276

r Revised.

Table 8.—U.S. imports for consumption and gypsum and gypsum products

(Thousand short tons and thousand dollars)

Year	Crude (including anhydrite): Quantity	Crude (including anhydrite): Value	Ground or calcined: Quantity	Ground or calcined: Value	Alabaster manufactures[1] value	Other manufactures n.e.c., value	Total value
1970	6,128	13,791	2	106	1,559	1,125	16,581
1971	6,094	13,447	2	105	1,545	1,235	16,332
1972	7,718	18,342	2	152	1,950	1,598	22,042

[1] Includes imports of jet manufactures, which are believed to be negligible.

Table 9.—U.S. imports for consumption of crude gypsum (including anhydrite), by country

(Thousand short tons and thousand dollars)

Country	1971		1972	
	Quantity	Value	Quantity	Value
Canada	4,681	10,155	5,912	13,946
Dominican Republic	161	476	116	371
Italy	(1)	6	15	6
Jamaica	309	913	439	1,292
Mexico	943	1,897	1,236	2,727
Other	(1)	(1)	--	--
Total	6,094	13,447	7,718	18,342

[1] Less than ½ unit.

WORLD REVIEW

Canada.—Canada was the second leading producer of crude gypsum. Output in 1972 was 7.9 million tons of which 5.9 million tons was exported to the United States.

U.S. Gypsum Co., National Gypsum Co., Georgia-Pacific Corp., B. S. Parsons, and D. McDonald mined gypsum in Nova Scotia. U.S. Gypsum Co. and Canada Cement Lafarge Ltd. mined gypsum in New Brunswick. The Flintkote Co. mined gypsum in Newfoundland.

In the western provinces, Domtar Construction Materials Ltd. and Westroc Industries Ltd. mined gypsum in Manitoba. Westroc Industries Ltd. also mined gypsum in British Columbia.

Westroc Industries Ltd. announced plans to construct a $7.2 million gypsum wallboard plant near Montreal.

France.—France was the third leading gypsum producer, with shipments of over 6 million tons. Most of the gypsum was exported.

India.—Deposits of gypsum covering 700 square miles and estimated at 469 million tons have been discovered in the Kohat area. Gypsum reserves in Jammu and Kashmir are estimated at 79 million tons.

Netherlands.—Plans were announced for a new plant at Born for making plasterboard from byproduct gypsum. Annual capacity is estimated at 400,000 tons of gypsum.

South Africa, Republic of.—A new plant went on stream at Palabora, treating the byproduct gypsum from the phosphoric acid plant. Products of the new plant are sulfuric acid and a clinker that can be ground for portland cement.

Spain.—Spain was the sixth leading gypsum producer, with shipments of nearly 5 million tons. Most of the material was exported.

U.S.S.R.—The U.S.S.R. ranked fourth in gypsum production, with shipments of more than 5 million tons. Most of the gypsum was consumed in the Soviet Union.

TECHNOLOGY

Interest continued in the use of byproduct gypsum for producing wallboard and plaster. Sabina Industries holds the United States and Canadian rights to the patented Giulini process for the recovery of high-quality gypsum from waste gypsum. There are very large quantities of waste gypsum that must be used or disposed of.

American Cyanamid Co. announced that a new gypsum board plant would be built at Savannah, Ga. The gypsum would be recovered by a Japanese process from the waste water of the company's titanium dioxide plant.

Table 10.—Gypsum: World production, by country

(Short tons)

Country [1]	1970	1971	1972 p
North America:			
Canada (shipments) [2]	6,318,523	6,702,100	7,942,000
Dominican Republic e	r 143,300	143,300	143,300
El Salvador	6,120	e 6,600	e 6,600
Guatemala	8,499	e 8,800	e 8,800
Honduras	10,146	e 11,000	17,423
Jamaica	311,781	340,888	e 340,000
Mexico	1,422,927	1,431,071	1,650,946
Nicaragua [2]	e 33,000	27,789	e 28,000
Trinidad and Tobago	r 2,200	2,200	2,200
United States	9,436,000	10,418,000	12,328,000
South America:			
Argentina	464,693	650,650	e 660,000
Bolivia	[3] 551	[4] 2,204	[4] 2,544
Brazil e	320,000	320,000	320,000
Chile	140,288	168,019	192,028
Columbia	188,495	200,620	221,886
Paraguay	6,614	13,228	12,125
Peru	99,142	e 100,000	e 100,000
Venezuela e	r 110,000	110,000	110,000
Europe:			
Austria [2]	694,270	654,462	949,372
Belgium	96,962	106,296	115,940
Bulgaria	r 187,400	198,400	e 200,000
Czechoslovakia	536,800	528,000	e 525,000
France [2]	r 6,320,243	5,634,458	6,451,380
Germany, East [5]	318,570	347,230	e 347,000
Germany, West (marketable)	r 1,619,293	1,756,354	1,970,930
Greece	340,121	363,800	e 365,000
Ireland	324,801	e 330,000	e 330,000
Italy	r 3,693,242	e 3,860,000	e 3,860,000
Luxembourg	5,580	5,898	5,390
Poland e	937,000	937,000	937,000
Portugal	r 214,388	259,449	e 265,000
Spain	r 4,548,839	4,442,928	4,520,000
Switzerland e	110,000	110,000	110,000
U.S.S.R. e	5,200,000	5,200,000	5,200,000
United Kingdom [2]	4,712,968	4,599,848	4,589,769
Yugoslavia	276,260	275,843	e 276,000
Africa:			
Algeria e	193,000	193,000	193,000
Angola	20,062	21,818	16,103
Egypt, Arab Republic of	r 481,218	580,909	584,000
Ethiopia	5,126	3,948	5,126
Kenya [2]	66,223	101,271	e 110,000
Libya	4,189	e 4,400	e 4,400
Niger	r 1,653	441	1,653
South Africa, Republic of	452,058	450,003	462,300
Sudan [2]	1,804	e 2,200	e 2,200
Tanzania	22,838	19,501	[4] 2,794
Asia:			
Burma	5,880	13,440	15,160
China, People's Republic of e	606,300	606,300	661,400
Cyprus	r 49,267	19,032	30,800
India	1,014,716	1,199,313	1,188,290
Indonesia e	8,800	8,800	8,800
Iran [6]	2,314,851	2,480,197	e 2,500,000
Israel [7]	77,162	88,185	e 88,000
Japan	593,895	582,802	512,537
Jordan	28,660	26,455	33,069
Lebanon	38,581	40,785	e 44,000
Mongolia e	27,600	27,600	27,600
Pakistan	184,661	147,173	169,908
Philippines	19,244	47,174	93,636
Saudi Arabia [8]	18,994	39,602	e 40,000
Syrian Arab Republic e	16,500	16,500	16,500
Taiwan	12,484	18,010	6,515
Thailand	159,008	185,081	98,993
Turkey e	352,700	374,800	e 375,000
Oceania:			
Australia	931,941	986,847	e 1,150,000
Total	r 56,868,431	58,552,022	63,545,417

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] Exports.
[4] Net exports.
[5] Crude production estimates based on calcined figures.
[6] Year ended March 20 of year following that stated.
[7] Year ended March 31 of year following that stated.
[8] Data presented are for Hejira calendar years as follows: 1970—Hejira year 1390 (March 9, 1970—February 26, 1971); 1971—Hejira year 1391 (February 27, 1971—February 15, 1972); 1972—Hejira year 1392 (February 16, 1972—February 3, 1973).

Helium

By Gordon W. Koelling [1]

Sales of high purity helium (99.995% purity) in the United States during 1972 increased 9% to a total of 489 million cubic feet.[2] Approximately 36% of this total was sold by the Bureau of Mines and 64% was accounted for by private industry plant sales. Exports of high purity helium, all by private industry, totaled 138 million cubic feet in 1972. The f.o.b. Bureau of Mines plant price for high purity helium sold during the year remained at $35 per thousand cubic feet while private industry plant prices averaged $21 per thousand cubic feet.

In compliance with an order of the U.S. District Court for the District of Kansas issued on March 27, 1971, the Bureau of Mines continued to accept helium during 1972 under three of four conservation contracts whose termination provisions had been invoked by the Secretary of the Interior. This order was affirmed on appeal on the ground that the requirements of the National Environmental Policy Act had not been complied with. On November 13, 1972, the Department released an environmental impact statement prepared in furtherance of an evaluation of the environmental consequences of termination of the contracts.

A ruling made by the U.S. Court of Claims on January 21, 1972, held that the Government had materially breached its agreement with the fourth contractor. The issue of damages is pending. This firm continued to deliver helium to the Bureau of Mines for storage to its account, pursuant to an interim storage agreement until expiration of the agreement on September 28, 1972.

DOMESTIC PRODUCTION

A total of 12 helium extraction plants were in operation during 1972. Of these two were owned by the Federal Government and operated by the Bureau of Mines, five were private industry plants extracting helium primarily for long-term conservation storage, and five were private industry plants producing helium for independent sale to commercial (non-Federal) customers.

Total helium extracted from natural gas during 1972 declined approximately 10% to 4,089,501 thousand cubic feet despite a 9% increase in the output of high purity helium to 627,250 thousand cubic feet. Approximately 85% of total helium extracted was crude helium[3] and 15% was high purity helium produced for sale. About 92% of crude helium production was from private industry conservation plants and 72% of high purity output was from private industry plants producing for sale to commercial customers. The remaining 8% of crude and 28% of high purity helium produced was extracted by Bureau of Mines plants.

Of the 438,665 thousand cubic feet of helium produced by the Bureau of Mines Keyes and Exell plants in 1972, approximately 88% was extracted from natural gas supplied by a private natural gas pipeline company on a gas-processing contract basis. The remaining 12% was extracted from natural gas that was produced from the Bureau of Mines Cliffside gasfield primarily in order to create additional reservoir space for helium conservation storage. All helium extraction from Cliffside natural gas occurred at the Exell plant.

---

[1] Geographer, Division of Fossil Fuels.

[2] All helium statistics in this chapter are reported in terms of contained helium measured at 14.7 pounds per square inch absolute and 70° F.

[3] Helium mixed with various quantities of other light gases, mostly nitrogen.

Table 1.—Helium extracted from natural gas in the United States

(Thousand cubic feet)

	1968	1969	1970	1971	1972
Crude helium: [1]					
Extracted at Bureau of Mines plants	199,300	306,200	429,400	504,406	262,147
Extracted at private industry plants	3,591,700	3,596,300	3,523,800	3,483,919	3,200,104
Total	3,791,000	3,902,500	3,953,200	3,988,325	3,462,251
High purity helium: [2]					
Extracted at Bureau of Mines plants	478,400	360,700	230,700	173,626	173,575
Extracted at private industry plants	388,700	398,800	416,500	403,152	453,675
Total	867,100	759,500	647,200	576,778	627,250
Grand total	4,658,100	4,662,000	4,600,400	4,565,103	4,089,501

[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.

Table 2.—Ownership and location of helium extraction plants in the United States, 1972

Category and owner or operator	Location	Type of production
Government owned:		
Bureau of Mines	Exell, Tex	Crude helium.
Do	Keyes, Okla	Crude and high purity helium.
Private industry, conservation:		
Cities Service Helex, Inc	Ulysses, Kans	Crude helium.[1]
National Helium Corp	Liberal, Kans	Crude helium.
Northern Helex Co	Bushton, Kans	Do.
Phillips Petroleum Co	Dumas, Tex	Do.
Do	Hansford County, Tex	Do.
Private industry, other:		
Alamo Chemical-Gardner Cryogenics	Elkhart, Kans	High purity helium.
Cities Service Cryogenics, Inc	Scott City, Kans	Crude helium.[2]
Kansas Refined Helium Co	Otis, Kans	High purity helium.
Kerr-McGee, Corp	Navajo, Ariz	Do.
Western Helium Co	do	Do.

[1] Also purifies crude helium piped from Cities Service Cryogenics, Inc., plant at Scott City, Kans.
[2] Crude helium is piped to Cities Service Helex, Inc., plant at Ulysses, Kans. for purification.

Table 3.—Summary of Bureau of Mines helium plant and Amarillo shipping terminal operations, 1971 and 1972

(Thousand cubic feet)

	1971	1972
Supply:		
Inventory at beginning of period [1]	13,557	11,474
Helium extracted: [2]		
Exell plant:		
Crude	234,119	99,391
High purity [3]	50,304	--
Total Exell plant	284,423	99,391
Keyes plant:		
Crude	270,287	162,756
High purity [3]	123,322	176,518
Total Keyes plant	393,609	339,274
Total extracted	678,032	438,665
Helium returned in containers (net)	244	2,635
Total supply	691,833	452,774
Disposal:		
Sales of high purity helium [3]	173,626	173,575
Net deliveries to helium conservation system [4]	506,733	263,057
Inventory at end of period [1]	11,474	16,142
Total disposal	691,833	452,774

[1] At Exell and Keyes plants and at Amarillo shipping terminal.
[2] Excludes conservation helium produced from native gas withdrawal wells at Cliffside field, which have been invaded by stored helium.
[3] Includes only those quantities produced for sale; quantities entering conservation after purification are included under crude helium.
[4] Excludes return of conservation helium produced as indicated in footnote 2 to conservation storage system.

Extensive modernization of the Exell plant was incomplete at yearend because of delays caused by technical problems. The new facilities included in this modernization program are for the purpose of consolidating operations, improving efficiency, and facilitating underground helium storage operations.

CONSUMPTION AND USES

Domestic sales of high purity helium rose 9% during 1972 in a moderate reversal of a 5-year declining trend. Much of the 1972 increase was attributable to the overall improvement in the Nation's economy and increased requirements for helium in research and in breathing mixtures.

Although the quantity of helium sold by the Bureau of Mines in 1972 was almost the same as in 1971, the share of the domestic helium market accounted for by the Bureau declined from 39% in 1971 to 36% in 1972. This resulted from a lack of growth in the need for helium on the part of Federal agencies, which are required by law to purchase all of their major requirements from the Department of the Interior. The f.o.b. Bureau of Mines plant price, which is set at $35 per thousand cubic feet for the purpose of financing the long-range helium conservation program, was not competitive with the 1972 average f.o.b. private plant price of $21 per thousand cubic feet.

Approximately 30% of Bureau sales in 1972 were through 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 and reduced freight charges for small purchases.

Domestic consumption of helium during 1972 was primarily for purging and pressurizing rockets and spacecraft, research, welding, maintenance of controlled atmospheres, leak detection, and cryogenics. Demand occurred principally in the States along the west and gulf coasts.

All helium sold by the Bureau of Mines was shipped in gaseous form in cylinders, highway semitrailers, or railway tank cars. Private industry plants shipped helium in both gaseous and liquid form. Much of the helium transported in liquid form was delivered by semitrailers to distribution centers, where most of the product was gasified and compressed into small cylinders and trailers for delivery to consumers.

Table 4.—Total sales of high purity helium in the United States

(Million cubic feet)

Year	Quantity
1968	[e] 802
1969	[e] 670
1970	[e] 542
1971	447
1972	489

[e] Estimate.

Table 5.—Bureau of Mines sales of high purity helium, by recipient, 1971 and 1972

(Thousand cubic feet)

	1971	1972
Federal agencies:		
Atomic Energy Commission	19,175	17,447
Department of Defense	82,355	61,627
National Aeronautics and Space Administration	32,905	35,775
National Weather Service	3,066	2,940
Other [1]	1,062	3,346
Total Federal agencies	138,563	121,135
Non-Federal customers [2]	35,063	52,440
Grand total	173,626	173,575

[1] Includes quantities used by Bureau of Mines.

[2] Most of this was purchased in bulk by commercial firms, repackaged in smaller containers, and then sold to Federal installations under contract arrangements with the General Services Administration.

CONSERVATION

The purchase of crude helium by the Bureau of Mines, under the terms of contracts entered into with three private producers in 1961, continued in compliance with a court order obtained during 1971 by Cities Service Helex, Inc., National Helium Corp., and Phillips Petroleum Co. The Bureau also accepted helium from the contractor not involved in that litigation, Northern Helex Co., for storage to that company's account until expiration of an interim storage agreement on September 28, 1972.

Helium held in the Bureau of Mines conservation storage system, which includes the conservation pipeline system and the partially depleted Cliffside gasfield near Amarillo, Tex., increased 11% during 1972 to a yearend total of 35,630,904,000 cubic feet. Of this total, 97% was stored under the Bureau's conservation program and the remaining 3% was stored under contract for private producer's own accounts. Approximately 8% of the net addition to the helium conservation system in 1972 was accounted for by deliveries from Bureau plants, 76% was acquired from private industry conservation plants for the conservation program, and 16% was added to storage under contract for private producers' own accounts. Most of the latter was accounted for by quantities stored under an interim agreement for the account of Northern Helex Co.

Table 6.—Summary of Bureau of Mines helium conservation system [1] operations, 1971 and 1972

(Thousand cubic feet)

	1971	1972
Helium in conservation storage system at beginning of period:		
Stored under Bureau of Mines conservation program	28,118,119	31,635,937
Stored under contract for private producers' own accounts	58,972	531,806
Total	28,177,091	32,167,743
Input to system:		
Net deliveries from Bureau of Mines plants [2]	506,733	263,057
Acquired from private industry conservation plants	3,011,085	2,729,595
Stored under contract for private producers' own accounts	537,671	583,748
Total	4,055,489	3,576,400
Redelivery of helium stored under contract for private producers' own accounts	64,837	113,239
Net addition to system	3,990,652	3,463,161
Helium in conservation storage system at end of period:		
Stored under Bureau of Mines conservation program	31,635,937	34,628,589
Stored under contract for private producers' own accounts	531,806	1,002,315
Total	32,167,743	35,630,904

[1] Includes conservation pipeline system and Cliffside field.
[2] 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.—Helium purchased for Bureau of Mines conservation storage, 1971 and 1972

(Thousand cubic feet)

Company	Helium delivered	
	1971	1972
Cities Service Helex, Inc.[1]	741,902	699,038
National Helium Corp.[1]	1,165,251	1,107,897
Northern Helex Co.[2]	147,463	--
Phillips Petroleum Co.[1]	956,469	922,660
Total	3,011,085	2,729,595

[1] Deliveries from these companies accepted in compliance with order of the Federal District Court for the State of Kansas after 8:00 a.m., March 28, 1971, when termination provisions of these companies' helium conservation contracts were to have taken effect.
[2] This company ceased delivery of helium for Bureau of Mines conservation program as of 8:00 a.m., March 28, 1971.

Table 8.—Deliveries of crude helium from private industry conservation plants to Bureau of Mines conservation storage system, 1972

(Thousand cubic feet)

Owner	Plant location	Delivered for Bureau of Mines conservation storage	Stored for companies' own accounts in Bureau of Mines conservation system			Total
			Delivered	Withdrawn	Net	
Cities Service Helex, Inc.	Ulysses, Kans.	699,038	88,654 [1]	53,690 [1]	34,964	734,002
National Helium Corp.	Liberal, Kans.	1,107,897	51,878	6,696	45,182	1,153,079
Northern Helex Co.	Bushton, Kans.	--	429,471	43,107	386,364	386,364
Phillips Petroleum Co.	Dumas, Tex.	521,378	13,745	9,746	3,999	926,659
Do.	Hansford County, Tex	401,282				
Total		2,729,595	583,748	113,239	470,509	3,200,104

[1] Includes some helium stored for the account of Cities Service Cryogenics, Inc., which pipes its output to Cities Service Helex, Inc., for purification.

RESOURCES

Proved and probable helium reserves (in natural gas with a minimum helium content of 0.3%) in the United States, exclusive of those quantities in conservation storage at the Cliffside field, were estimated at 120.2 and 15.7 billion cubic feet, respectively, as of December 31, 1972. The total 135.9 billion cubic feet of proved and probable reserves available at yearend was almost 6% less than at the beginning of the year.

Although proved and probable helium reserves were contained in the natural gas reservoirs of over 100 gasfields located in 10 States, the bulk of reserves were in four fields: the Greenwood field in Kansas and Colorado; the Hugoton field in Kansas, Oklahoma, and Texas; the Keyes field in Oklahoma; and the West Panhandle field in Texas. Almost 83% of proved and probable reserves were in fields being produced at yearend 1972. Approximately 51% of the helium-rich (0.3% helium content) natural gas produced was being processed for helium extraction, and helium contained in the remaining helium rich natural gas output was being wasted incident to the consumption of the gas.

The Bureau of Mines continued its efforts to identify helium resources in the United States and other parts of the world. A total of 369 natural gas samples from 25 States and four foreign countries, Australia, Canada, Indonesia, and the United Kingdom, were collected and analyzed for helium content during 1972. None of these samples indicated the occurrence of significant helium resources.

FOREIGN TRADE

Exports of high purity helium in 1972 increased 6% and comprised 22% of the U.S. helium industry's total high purity sales as compared with 23% during 1971. All exports were from private industry extraction plants, which depended on foreign markets for 30% of their total high purity sales in 1972. Most of the quantity shipped was destined for Western Europe.

Table 9.—Exports of high purity helium from the United States

(Million cubic feet)

Year	Quantity
1968	e 65
1969	e 90
1970	e 105
1971	130
1972	138

e Estimate.

WORLD REVIEW

Helium produced outside the United States during 1972 totaled an estimated 122 million cubic feet. Canada produced approximately 35 million cubic feet from a single plant in Saskatchewan, mostly for export to Japan and other Asian countries, although some was used in Canada. A plant in France produced about 7 million cubic feet of helium as a byproduct of nitrogen removal operations. The countries of Eastern Europe extracted an estimated 80 million cubic feet during the year.

During 1972, Petrocarbon Developments, Ltd., of the United Kingdom was in the process of planning the construction of a helium and nitrogen extraction plant which it is to build under contract in Poland. This plant is to separate helium and nitrogen from natural gas that has a nitrogen content of about 45%. A helium purification and liquefaction unit to be integrated with the nitrogen removal process is to have a high purity helium output capacity of 150 million cubic feet per year. Completion of this project was scheduled for mid-1974.

TECHNOLOGY

Gulf General Atomic Co., a subsidiary of Gulf Oil Corp., initiated a preliminary planning study of a helium gas turbine for the Atomic Energy Commission during 1972. This study is to assess the commercial feasibility of developing a helium-cooled nuclear reactor and employing the same helium in a closed cycle to drive the gas-turbine generator. This would eliminate the steam-turbine cycle ordinarily used in powerplants and allow heat rejection to take place directly to air in dry cooling towers. It would also eliminate thermal pollution of streams, and would allow utility companies more flexibility in picking their powerplant sites. The gas turbines themselves could be located inside the same containment vessel that housed the reactor core, thus offering a capital cost savings.

Two Japanese companies, Teijin Ltd., and Nippon Sanso KK, reportly have developed a helium recovery and refining system that utilizes selective permeability of helium gas through synthetic high polymer film. Operating costs for such a system are stated to be approximately 30% lower than for conventional methods, although the initial investment for equipment is similar. The new system is expected to find wide application in the recovery and refining of helium from gas mixtures used for breathing in deep-sea operations, or from contaminated helium evaporated from hyper-refrigerating equipment.

Iron Ore

By F. L. Klinger [1]

The relatively low demand for iron ore that developed during 1971 carried over into the first half of 1972. With large inventories of ore at mines and consuming plants, mine production or shipments were reduced in many of the principal iron ore producing and exporting countries. There was a strong increase in demand in the latter part of the year, but the consequent rise in production and shipments was not quite enough to push world production or trade above the levels of 1971. Consumption of iron ore, however, increased about 9% in the United States, 6% in the European Economic Community (EEC), and also increased in Japan and the Soviet Union in 1972.

Production and exports of iron ore declined substantially in the United States, Canada, Chile, Venezuela, and Angola, while small to moderate increases in production or exports were reported from Australia, Brazil, India, Liberia, Mauritania, Peru, and the U.S.S.R., compared with those in 1971. Imports of iron ore by the United States and Japan declined by 3 to 4 million tons but increased slightly in the EEC and probably increased to some extent in East European countries which receive most of their ore supplies from the U.S.S.R. Canadian production and exports were hampered by strikes at some major mines and ports during the summer, while cutbacks in imports of ore by Japan in 1972 were further affected by a Japanese shipping strike which lasted from April to July.

Australia continued to be the world's leading exporter of iron ore in 1972, as well as the third largest producer after the U.S.S.R. and the United States. Japan, which imported more than 100 million tons of ore for the third consecutive year, remained the world's largest importer, followed by West Germany and the United States.

World shipments of iron ore pellets were estimated at 125 million tons in 1972, equivalent to about 95% of estimated world production capacity at the beginning of the year. The United States accounted for 43% of the total; Canada, for 18%; and 18 other countries for the remainder. World production capacity for pellets increased to an estimated 146 million tons annually by yearend, and 16 million tons of additional capacity was anticipated during 1973.

World output of prereduced iron ore appeared to be below the capacity of existing plants, partly due to technical problems. The Falconbridge Nickel Mines Ltd. plant at Sudbury, Ontario, was to close early in 1973, but a new plant was completed at Houston, Tex., in 1972 and another was scheduled for completion at Contrecoeur, Quebec in 1973.

Iron ore prices were relatively stable in 1972, but devaluation of the dollar and realignment of foreign currencies in 1971 were causing problems. Australian producers, whose contracts with Japanese importers were mainly based on dollar values prior to 1971, were pressing for upward adjustment of contractual prices. Swedish producers, whose contracts with European buyers are usually based on the krona, were forced late in 1972 to reduce export prices for 1973 deliveries by as much as 15% in order to meet competition in European markets from Australian and other foreign ores. However, U.S. prices for Lake Superior iron ores and pellets, delivered at lower lake ports, began to rise in December 1972, and by the beginning of the 1973 shipping season prices were 5% to 6% higher than those prevailing 1 year earlier.

In transportation of iron ore, the size of carriers continued to increase, with individual cargoes up to 166,000 tons reported in oceanborne trade and up to 55,000 tons on the Great Lakes. Some ocean cargoes of more than 200,000 tons were expected in

[1] Physical scientist, Division of Ferrous Metals—Mineral Supply.

1973. Capacity of offloading ports to receive large carriers was increased, especially in Japan and the United Kingdom. Ocean shipments of iron ore slurries increased to at least 1.3 million tons in 1972. Ocean freight rates were low in early 1972 but by yearend were approaching the high levels of early 1971.

Table 1.—Salient iron ore statistics

(Thousand long tons and thousand dollars)

	1968	1969	1970	1971	1972
United States:					
Iron ore (usable [1] less than 5% Mn):					
Production [2]	85,865	88,328	89,760	80,762	75,434
Shipments [3]	81,934	89,854	87,176	77,106	77,884
Value [3]	836,433	929,293	941,738	891,001	950,365
Average value at mines per ton	10.21	10.34	10.80	11.55	12.20
Exports	5,884	5,160	5,492	3,061	2,095
Value	70,835	62,310	67,898	38,147	26,776
Imports for consumption	43,941	40,732	44,891	40,124	35,761
Value	453,753	402,178	479,518	450,644	415,934
Consumption (iron ore and agglomerates)	131,753	140,235	131,571	116,196	126,943
Stocks Dec. 31:					
At mines	16,041	13,566	15,316	17,653	14,679
At consuming plants	53,232	50,935	52,781	57,738	50,061
At U.S. docks	2,797	2,648	3,403	3,424	2,612
Manganiferous iron ore (5% to 35% Mn):					
Shipments	245	385	329	177	131
World: Production	668,142	701,495	757,013	767,025	756,826

[1] Direct shipping ore, washed ore, concentrates, agglomerates, and byproduct ore (mainly pyrite cinder and agglomerates).
[2] Includes byproduct ore.
[3] Excludes byproduct ore.

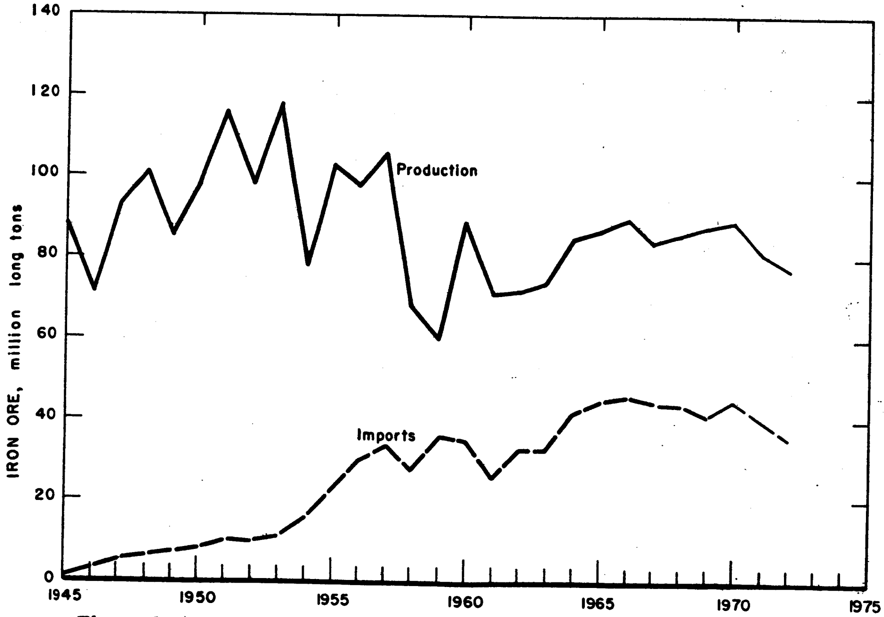

Figure 1.—United States iron ore production and imports for consumption.

EMPLOYMENT

The average number of men employed at U.S. iron ore mines and associated beneficiating plants was about 14,500 in 1972, a decline of 8.8% compared with the previous year. The reduction was mainly due to mine closures in Minnesota and New York, and to cutbacks in production in Minnesota and California.

The reduction in employment was accompanied by declines of 4.6% in output of crude ore and 6.2% in production of usable ore, compared with 1971. Total hours worked and the number of man-shifts were 9.6% less than in 1971 but productivity continued to rise. Output per man-shift increased 5.8% in crude ore and 3.9% in usable ore. Productivity in the Lake Superior district was 11% to 13% greater than the national average; this district accounted for 69% of total employment and 82% of U.S. production in 1972.

Employment and productivity data for 1972 are summarized in table 4. As in previous years, the employment figures do not include office workers at mines and associated beneficiating plants.

DOMESTIC PRODUCTION

Low demand for iron and steel, coupled with large stockpiles of ore at U.S. mines and consuming centers and a sharp reduction in export demand, led to the lowest production of usable ore from U.S. mines in 9 years. Output in 1972 was 6.6% less than in 1971 and 16% lower than in 1970. Mine shipments fared somewhat better, lagging behind 1971 levels for the first 8 months of the year, but with sharply increased demand and extension of the shipping season by several companies during the fourth quarter, 1972 shipments exceeded those of 1971 by 1% by yearend. Vessel shipments of ore from U.S. ports on the Great Lakes totaled 63.6 million long tons in 1972, 6% more than in 1971.

Despite the decline in total output of usable ore, production and shipments of iron ore pellets continued to increase. Pellets made up 71% of usable ore production and shipments in 1972 compared with 66% in 1971. The average iron content of usable ore produced also continued to rise, to 60.8%.

Crude ore production in 1972 was 4.5% less than in 1971. The average iron content of crude ore produced was 33.7%. The latter figure, however, represents total iron contained; the percentage of recoverable iron, as in the the taconite operations, is usually much less. The average content of recoverable iron in total crude ore produced was 24.4%. The ratio of crude ore produced per ton of usable product (excluding byproduct ore) in 1972 was 2.50:1, compared with 2.45:1 in the previous year. Production of direct-shipping ore was slightly more than in 1971, but the declining trend evident for the last 20 years was expected to continue.

The Lake Superior district produced 81.6% of the Nation's output of usable ore in 1972 and about 83% of all crude ore mined. Minnesota accounted for 65% of the total output of usable ore; Michigan for 15.5%, Wisconsin for 1% and the remainder was produced in 17 other States, of which the principal producers were California, Missouri, Wyoming, Utah, New York, and Pennsylvania. Production came from 58 mines, including 48 open pits, seven underground mines, and three combined underground and open pit operations. The number of operating mines was 16 fewer than in 1971, but this reduction was mainly due to temporary inactive status of a number of smaller producers which continued to ship ore from stockpiles in 1972.

In Minnesota, United States Steel Corp. completed expansion of the Minntac mine and plant in August 1972. The expansion doubled production capacity for pellets to 12 million tons per year. Improvements in productive capacity for pellets were also evident at plants in Eveleth and Nashwauk, so that nominal productive capacity for pellets at Minnesota taconite operations was probably about 41 million tons per year at the end of 1972. No decisions were announced concerning construction of the proposed 4-million-ton pellet plant at Hibbing. In other developments, the Hill-Trumbull mine did not produce ore in 1972 and the property was returned to the fee owners by Mesaba Cliffs Mining Co. Jones & Laughlin Steel Corp. leased the Delaware properties on the western Mesabi from United States Steel Corp.; these properties are adjacent to the Hill-Annex mine and concentrator operated by Jones & Laughlin at Calumet and are expected to increase the company's production from Minnesota mines in 1973. A work stoppage affecting 1,300 employees of the Hanna Mining Co. lasted from June 9 to July 22 and virtually ceased production at the Pierce natural-ore mine and at the Butler and National taconite plants during this period. Alleged pollution of Lake Superior, by taconite tailings discharged from the Reserve Mining Co. concentrator at Silver Bay, continued to be a controversial issue in 1972. The U.S. Department of Justice filed suit against the company in February and by midyear 17 other parties were permitted by the court to intervene. The States of Michigan and Wisconsin supported the Federal Government's case, while the company was supported by a number of county, municipal, and civil bodies.

In Michigan, Cleveland-Cliffs Iron Co. continued construction of the Tilden nonmagnetic taconite project near Ishpeming. Completion of the mine and concentrator, which will produce 4 million tons of iron ore pellets per year from 10 million tons of crude ore, is scheduled for mid-1974. Project design and construction is managed by Kaiser Engineers of Michigan, Inc., and the pelletizing plant will be supplied by Allis-Chalmers Corp. of Milwaukee, Wis. Cleveland-Cliffs also announced that production capacity for pellets at the Empire mine would be increased by 1.8 million tons annually by mid-1974. The expansion will cost an estimated $65 million and will raise production capacity for pellets to 5.2 million tons per year.

In California, the Beck mine in northern San Bernardino County had its first full year of production in 1972. The mine is operated by Standard Slag Co., producing lump and fine magnetite concentrates for export to Japan under a 5-year contract to supply 2.5 million tons of concentrate by the end of 1976. The company closed the Minnesota mine near Wabuska, Nev., in 1971 and shipped the last cargo of ore from Stockton, Calif., in March 1972. Ore from the Beck mine is exported from Los Angeles.

In Alabama, the Woodward Co. (division of the Mead Corp.) announced that its last operating blast furnace would be shutdown early in 1973. About 265 employees will reportedly be affected. The company had stopped mining ore late in 1970.

In New York, the Tonawanda Iron Division of American Standard Inc. shutdown its blast furnace at Tonawanda in June 1972. About 160 employees were affected. The company had been producing about 200,000 tons of pig iron per year, mainly from Mesabi hematite ores.

In Pennsylvania, the Cornwall underground mine of Bethlehem Steel Corp. was closed in June 1972 due to flooding of underground workings. The mine's power supply was cut off when heavy rains flooded the powerplant at Lebanon, Pa. After depletion of a small open pit ore body in 1973, the mine was expected to be permanently closed. The Cornwall mine is the oldest operating iron mine in the United States, and has produced ore continually since 1742.

In Texas, the country's third commercial plant for direct reduction of iron ore was completed at Houston by Armco Steel Corp. in 1972. Production capacity of the plant was reported to be 1,000 tons per day of metallized ore or pellets.

In Alaska, the economic feasibility of producing iron ore from low-grade titaniferous magnetite deposits near Klukwan was being studied by Henry J. Kaiser (Consulting) Co. of Oakland, Calif., for the Mitsubishi Corp. of Japan. The study was expected to be completed in 1972. Rights to mine the deposits are presently held by United States Steel Corp.

In Tennessee, the pelletizing plant of Cities Service Co. was reportedly completed in 1972. The plant will pelletize byproduct iron ore derived from processing of sulfides.

CONSUMPTION

Total consumption of iron ore and agglomerates in 1972 was 9.2% more than in 1971. Consumption during the first 7 months of 1972 was 7% less than in the corresponding period of 1971, but with the recovery of demand for iron and steel in the latter part of the year, consumption exceeded the 1971 level by the end of September and during the last 3 months of the year it was 38% greater than in the last quarter of 1971.

Consumption of iron ore and agglomerates in blast furnaces in 1972 increased by 9.8% compared with 1971, but consumption in steelmaking furnaces was 21% less. The continuing decline in consumption by steel furnaces was due mainly to the declining number of operating open-hearth furnaces. In blast furnaces, the weight ratio of iron ore and agglomerates consumed to hot metal produced in 1972 was 1.55:1 compared with 1.54:1 in the previous year.

The share of pellets in total consumption of iron ore and agglomerates rose to at least 52% in 1972, compared with 48% in 1971. Both domestic and foreign pellets are included in this figure. Domestically produced pellets made up 46% of total consumption, and 56% of the agglomerates consumed; corresponding figures for 1971 were 41% and 52% respectively.

Consumption data are shown in table 13 and 14. In these tables, iron ore concentrate used to produce pellets or other agglomerates at mine sites was not reported as iron ore consumed; its consumption was reported only when such agglomerate was shipped to the furnaces site and used (table 13). However, concentrate and fines used for production of agglomerates (mainly sinter) at blast furnaces and steel plants was reported as iron ore consumed (table 14), and consumption of agglomerates derived from this source is included in table 13. In table 14, the difference in weight between iron ore consumed and agglomerates produced is due mainly to additives such as lime, mill scale, flue dust, coke breeze, and other materials used in making agglomerates.

STOCKS

Stocks of iron ore at U.S. mines, docks, and consuming plants totaled 67.3 million tons on December 31, 1972. The total was nearly 15% less than one year earlier and was the lowest since yearend 1969. The unusually large inventories at the beginning of 1972, coupled with the relatively low level of demand for iron and steel which carried over into the first half of the year, tended to depress mine production as well as imports of iron ore during 1972. Total stocks of iron ore and agglomerates at yearend represented about a 6-month supply at the average monthly rate of domestic consumption in 1972.

PRICES

Published prices for Lake Superior iron ores and iron ore pellets, after increasing by 3% to 5% in 1971, were unchanged during the first 11 months of 1972. However, in February the bulk vessel freight rate for iron ore shipped from the head of the lakes to lower lake ports was increased by 12 cents per gross ton, to $2.37. The effect of this was to increase the price of some ore at lower lake ports, since any increase in transportation costs would be borne by the buyer.

In December 1972 several companies announced increases in base prices amounting to about 4.7% for natural ores and 3.9% for pellets. As of January 1, 1973, published prices for natural ores, basis 51.5% iron, rail of vessel at lower lake ports, were 54 cents per gross ton higher than a year earlier and the price of pellets was increased to 29.1 cents per long ton unit of contained iron. The new prices for natural ores, per gross ton, were as follows; Mesabi non-Bessemer, $11.71; Mesabi Bessemer, $11.86; Old Range non-Bessemer, $11.96; and Old Range Bessemer, $12.11. Any increase in transportation or handling costs was to be borne by the buyer.

The average value of usable iron ore shipped from domestic mines in 1972 (excluding byproduct ore) was $12.20 per long ton, f.o.b. mine, compared with $11.55 in 1971 and $10.80 in 1970. The values were calculated from producer's statements and approximated the commercial selling price less the cost of mine-to-market transportation. The increase in average f.o.b. value reflected higher market prices as well as the increasing proportion of pellets in domestic iron ore shipments. Pellets made up 71% of domestic shipments in 1972, compared with 66.4% in 1971, and 61.7% in 1970.

Although information on prices for foreign iron ores was very limited, indications were that prices during most of 1972 were unchanged or slightly lower than those of 1971. This appeared to be due to relatively low world demand for iron ore in the first 8 months of 1972 and was in contrast to rising price trends in 1970 and 1971. Prices for Brazilian and Swedish ores were stable while somewhat lower prices were indicated by exporters in Norway and Mauritania. Also, f.o.b. or c.f. prices for many foreign iron ores in 1972 appeared to be fixed under long-term contracts with Japanese buyers. The price situation was complicated, however, by devaluation of the dollar and realignment of foreign currencies in 1971, along with the fact that many iron ore delivery contracts were based on prices quoted in U.S. dollars. This resulted in loss of revenue for many exporters and was further complicated by rapidly rising ocean freight rates in the latter part of 1972. Consequently, there was increasing pressure for upward revision of dollar contract prices to compensate for the shifting exchange rates. At the same time, however, dollar-priced ores became cheaper in world markets, strengthening their competitive position relative to iron ores priced in other currencies. The latter situation, late in 1972, forced Swedish exporters, whose contracts are based on kronor prices, to reduce prices for 1973 deliveries by 12% to 15% for high-phosphorus ores and by 6% to 10% for other Swedish ores, in order to protect their traditional markets against competition from imports of iron ore from Australia and other countries.

Some published prices for foreign iron ores, believed to be applicable to deliveries in 1972 under contracts with Japanese buyers, are tabulated below. Because of widely differing chemical and physical properties and conditions of shipment, these prices are not necessarily comparable to prices for other foreign ores; they are presented here as possible indicators of price ranges for similar products in 1972.

Origin	Company or deposit	Type of product	Contract price	Terms and port
Angola	Cassinga	Lump, 64% Fe	$8.14/ldt	f.o.b. Porto Salazar.
	do	Fines, 64% Fe	6.50/ldt	Do.
Australia	Hamersley Iron Pty. Ltd.	Sized lump, 62% to 64%Fe.	9.92/ldt	f.o.b. Dampier.
	do	Fines, 62% to 64% Fe	7.63/ldt	Do.
	Mt. Newman Mining Co. Pty. Ltd.	Lump (6 x 30 mm), 62% to 64% Fe.	9.37/ldt	f.o.b. Port Hedland.
	Robe River	Pellets, 62.5% Fe	18.5 cents/1% Fe.	f.o.b. Cape Lambert.
	do	Fines, 56.5% Fe	9.0 cents/1% Fe.	Do.
	Savage River	Pellets, 66% to 67% Fe.	19.5 cents/1% Fe.	f.o.b. Port Latta.
Brazil	Aguas Claras [1]	Fines, 64% to 66% Fe	7.55/n.s	f.o.b. Sepetiba.
	do	Coarse ore, 64% to 66% Fe.	9.35/n.s	Do.
Canada	Carol Lake	Pellets, 65% Fe	24.2 cents/1% Fe (ldt).	f.o.b. Sept-Îles.
	Quebec Cartier Mining Co.	Concentrates, 62% to 63% Fe.	16.5 cents/1% Fe (ldt).	c.f. Japan.
Chile	Algarrobo	Lump, 62% Fe	7.50/ldt	f.o.b. Huasco.
	do	Fines, 60% Fe	5.45/ldt	Do.
India	Bailadila	Lump, 63% to 65% Fe.	9.73/ton	f.o.b.t. Vizagapatnam (inner harbor).
	Chowgule & Co	Lump, 59% Fe	5.85/n.s	f.o.b. Goa.
	do	Fines, 62% Fe	4.40/n.s	Do.
	do	Pellets, 65% to 66% Fe.	23.9 cents/1% Fe.	c.f. Japan.
New Zealand	Waipipi	Concentrates, 56% to 58% Fe, 8% TiO_2.	15.749 cents/ 1% Fe (ldt).	Do.
U.S.S.R.	Krivoy Rog	Concentrates, 60% to 62% Fe.	4.50/mdt	f.o.b. Iliichevsk.
	do	Lump, 50% to 55% Fe.	3.50/mdt	Do.

c.f. Cost and freight. f.o.b. Free on board. f.o.b.t. Free on board, trimmed. ldt Long dry ton. mdt Metric dry ton. n.s. Weight unit not stated.

[1] For period 1973–76.

Source: The TEX Report (Tokyo). Iron Ore Import '71. 1972, 228 pp.

TRANSPORTATION

The trend toward use of larger ore-carrying vessels to reduce unit transportation costs was continued in 1972 on the U.S. Great Lakes as well as in oceanborne trade.

On the Great Lakes, the vessel *Stewart J. Cort* of about 58,000-gross-ton cargo capacity was placed in service in May by Bethlehem Steel Corp. In June, the *Roger Blough* of about 45,000-ton cargo capacity was placed in service by United States Steel Corp. The cargo capacity of each vessel was more than 50% greater than the largest carriers previously operated on the lakes. The vessels were used to transport iron ore pellets from Minnesota ports on Lake Superior to steelworks on the south shore of Lake Michigan. These two vessels transported a combined total of more than 3 million tons of pellets during the 1972 shipping season.

Several of the existing lake carriers were being lengthened to increase cargo capacity. The capacity of two vessels was each increased by 15% to about 30,000 tons in 1972, and similar modifications were planned for two smaller vessels during 1973.

Efforts to extend the lake shipping season were again successful in 1972. With increased icebreaker support, bubbler systems to eliminate channel ice, and other navigational aids, ore shipments continued until December 29 from Silver Bay, Minn., until January 1 from Superior, Wis., and until February 7, 1973, from Two Harbors, Minn. The number of vessels loaded at each U.S. port, the total tonnage shipped, and average size of cargo in the 1972 shipping season are shown in the following tabulation. The larger average cargo shipped from Two Harbors and Taconite Harbor, Minn., in 1972 was due to loadings of the two large carriers mentioned above.

Lake shipping port	Number of vessels loaded	Total tonnage shipped [1] (thousand long tons)	Long tons [2]	
			Average cargo	Largest cargo
Duluth, Minn	956	14,866	15,500	27,500
Taconite Harbor, Minn	463	10,600	22,900	55,800
Superior, Wis	559	10,172	18,200	NA
Silver Bay, Minn	547	9,481	17,300	27,700
Escanaba, Mich	596	9,357	15,700	27,300
Two Harbors, Minn	379	6,576	17,400	44,700
Marquette, Mich	183	3,062	16,700	25,200
Total	3,683	64,114	17,400	XX

NA Not available. XX Not applicable.
[1] Rounded to nearest 1,000 tons.
[2] Rounded to nearest 100 tons.

Source: Skillings' Mining Review. various issues, 1972–73.

Published freight rates for rail and vessel transport of iron ore from Lake Superior district mines to consuming centers, and dock-handling charges, in effect on April 15, 1972, were unchanged from those in effect 1 year earlier.[2] As noted in the section on prices, however, the bulk vessel freight rate for iron ore was actually increased by 12 cents per gross ton in February 1972, a rise of about 5% compared with the 1971 rate. After the close of the 1972 shipping season, new rates for rail and lake freight, and dock handling charges and storage costs at lower lake ports, were announced prior to the start of the 1973 shipping season. The cost of rail freight increased 4% to 6%, lake freight by 4%, dock handling charge at lower lake ports by 5% to 6%, and the dock storage charge at lower lake ports rose 20% (to 3 cents per ton).

In oceanborne iron ore trade, freight rates increased during 1972. The low rates prevailing late in 1971 continued over into the early months of 1972, but the Japanese seamen's strike which lasted from April to mid-July, and very large grain-shipping contracts negotiated by the United States with the Soviet Union and other countries during the spring and summer,

[2] University of Minnesota Bulletin. Mining Directory Issue 1972, table 14.

reduced the number of ships available to the iron ore trade and helped to drive up freight rates during the last half of the year. By yearend, freight rates from the principal iron ore exporting countries to consuming centers in North America, West Europe, and Japan were about double those in the spring, and indications were that the rates would rise further in 1973. Some rates for individual shipments in 1972 reported by various issues of Metal Bulletin were as follows:

Country and port	Destination	Tonnage of shipment	Rate per ton	
			Early 1972	Late 1972
Angola (Port Salazar)	West Europe	45,000–50,000	$2.15 (Dunkirk)	$4.00 (West Italy)
Australia (Dampier)	Belgium	50,000–60,000	3.25	6.50–6.80
Australia (Port Hedland)	Port Talbot or Amsterdam.	80,000–100,000	[e] 2.60 (Oct.–Nov. 1971)	4.62–6.00
Brazil (Tubarão)	Western Europe	50,000–70,000	2.00–2.15	4.00–4.85
Do	Japan	70,000–100,000	3.20–3.30	5.65
Do	Eastern United States	30,000–43,000	1.90 (Dec. 1971)	4.87 (Jan. 1973)
Canada (Sept-Îles)	United Kingdom, Italy, Netherlands.	50,000	1.30–1.80	3.25–3.45
Chile [1]	Japan	46,000–62,000	3.10	6.90
Liberia (Monrovia)	Netherlands	40,000–70,000	1.40	2.60
Mauritania (Port Etienne)	United Kingdom	22,000	2.50	3.50
Norway (Narvik)	United Kingdom	15,000	.75 (Port Talbot)	[e] 2.60 (Middlesbro)

[e] Estimate.
[1] Port not specified.

By the end of 1972, an estimated 11 foreign ports, two more than in 1971, were capable of loading iron ore carriers of 100,000 to 175,000 deadweight tons (d.w.t.). The number was expected to increase to 13 in 1973, with completion of a new port at Sepetiba Bay, Brazil, and expansion of facilities at Narvik, Norway. In 1973, three ports (Sept-Îles, Tubarão, and Sepetiba Bay) will be capable of loading carriers of 250,000 d.w.t. and a similar capacity was expected to be developed at Narvik by 1974.

At consuming centers, 13 foreign ports were capable of accommodating iron ore carriers of 100,000 to 150,000 d.w.t. in 1972. Nine of these were located at steelworks in Japan and the others were located in western Europe (Rotterdam, Amsterdam, Port Talbot, and Taranto). In Japan, the sea berth for the Oita works of Nippon Steel Corp. was expected to accommodate carriers of up to 300,000 d.w.t. in 1973. In the United Kingdom, where, except at Port Talbot, ore carriers of only about 20,000-35,000 d.w.t. could be accommodated, a new terminal at Immingham was completed in 1972 and the Redcar terminal at Teesside will be completed in 1973. These new facilities will initially permit berthing of 65,000 d.w.t. vessels at Immingham and 150,000 d.w.t. vessels at Teesside. In the United States, relatively shallow channel depths limited the size of incoming iron ore cargoes to a maximum of about 65,000 tons although cargoes of up to 80,000 tons were formerly exported from the port of Long Beach. New port facilities being constructed at the Sparrows Point, Maryland works of Bethlehem Steel Corp. in 1972 may permit berthing of 100,000 d.w.t. carriers in 1974 if the necessary channels are provided.

Slurry transport of iron ore increased in 1972. An estimated 1.3 million tons were shipped in special carriers to Japan, mainly from New Zealand and Peru. The largest single cargo reported during the year was 80,000 long dry tons. In overland transport, slurry pipelines of 20 to 30 miles in length are scheduled to be built for iron ore projects in Argentina and Mexico, and a feasibility study was being made for a proposed 200-mile pipeline in the Republic of South Africa.

Data on ocean shipments of iron ore from some foreign ports in 1972 are shown in the following tabulation, which may be compared with data shown for U.S. lake shipments.

Ocean shipping port	Number of vessels loaded	Total tonnage shipped (thousand long tons)	Long tons	
			Average cargo	Largest cargo
Tubarão, Brazil	431	27,864	64,600	166,000
Port Hedland, Australia [1]	[2] 412	[2] 25,605	e [2] 62,000	132,300
Dampier, Australia	288	22,117	76,800	159,300
Narvik, Norway [3]	e 530	20,175	e 38,000	85,600
Kirkenes, Norway [4]	100	2,541	25,800	e 135,000
Puerto Ordaz, Venezuela	375	14,550	39,000	NA
Sept-Îles, Canada	447	13,609	30,000	[2] 137,000
Buchanan, Liberia	215	11,147	51,800	NA
Mormugao, India	NA	11,107	NA	e 30,000
San Nicolas, Peru	136	8,900	65,000	142,000
Port Cartier, Canada	257	7,432	29,000	[2] 135,000
Porto Salazar, Angola	NA	4,967	NA	144,000
Guacolda, Chile	42	2,872	68,000	93,000

e Estimate. NA Not available.
[1] Total shipments from Mt. Newman and Goldsworthy projects.
[2] 1971 figure.
[3] Shipments of Swedish ore.
[4] A/S Sydvaranger.

Principal source: Skillings' Mining Review. Various issues, 1972–73.

FOREIGN TRADE

U.S. exports of iron ore in 1972 declined by 32% compared with those of 1971 and were the lowest since 1946. The reduction was mainly due to expiration of a long-term contract between the Mitsubishi Corp. of Japan and Kaiser Steel Corp. Shipments of ore to Japan from Kaiser's Eagle Mountain mine were terminated in December 1971. Exports of ore from California to Japan by the Standard Slag Corp. were expected to continue through 1975 at the rate of about 500,000 tons annually, under a contract expiring in 1976. About two-thirds of U.S. exports in 1972 went to Canada, mostly from ports on the Great Lakes.

U.S. imports of iron ore for consumption also declined in 1972 and were the lowest since 1963. The low volume of imports was mainly due to large inventories of ore at U.S. consuming plants and to relatively low demand for steel in the first half of the year. Imports of ore from Canada, which were reduced to some extent by strikes at some Canadian mines and ports, declined by 2.2 million tons, and imports from Venezuela declined by 2 million tons compared with those of 1971. Imports from Liberia and Peru increased, but imports from Australia and Brazil were down by more than 30% and imports from Chile dropped by 65% compared with the previous year.

In 1972 the average value of iron ore exports was $12.78 per long ton, compared with $12.46 in 1971, and the average value of imports was $11.63, compared with $11.23 in the previous year.

WORLD REVIEW

Argentina.—Late in 1972, financing was obtained for construction of concentrating, pelletizing, and transportation facilities for the Sierra Grande iron deposits in Rio Negro province. Loans granted to Hierro Patagonica de Sierra Grande, S.A., a Government-controlled company, included $20 million from the Canadian Export-Import Bank and $32 million from the Inter-American Development Bank.

A concentrator will be built at the mine site by 1975 by a Japanese group including the Mitsubishi Co. and Kurimoto Iron Works Ltd. Using magnetic separation and flotation processes, the plant will be capable of producing 2 million tons of iron concentrate (and possibly 200,000 tons of byproduct apatite concentrate) per year from 3.1 million tons of crude ore. A 30-kilometer pipeline will be built to carry iron-concentrate slurry to a pelletizing plant at Punta Colorada.

The pellet plant will be built by a group of companies headed by Wright Engineers Ltd. of Canada. The plant will employ the U.S. Midrex process although most of the equipment will be manufactured in Canada and Argentina.

Port facilities at Punta Colorada will be built by a group of German and Argentine firms, including Fried. Krupp G.m.b.H. of West Germany. The shipping distance from Punta Colorada to Buenos Aires is approximately 1,300 kilometers.

Argentine imports of iron ore totaled 1.59 million tons in 1971, more than twice the quantity imported in 1970. Domestic production of pellets from Sierra Grande is expected to substantially reduce Argentine import requirements, but in view of the Government's plans to double production of steel by 1980, the output from Sierra Grande may supply less than half of the country's ore requirements at that time.

Some barter agreements were made in 1972 by which Argentina would exchange steel and meat products for iron ore from Chile. Argentina also hoped to import iron ore from the Mutún deposits of Bolivia, but transportation continued to be a significant problem.

Australia.—Production and shipments of iron ore in 1972 were about 3% more than in 1971. Output from most producers was at relatively low levels in the first half of the year, partly due to reduced demand for ore in Australia, Japan, and other countries and partly to a 3-month strike by Japanese seamen. In some cases, shipments to Japanese consumers were less than the minimum quantities specified in contracts, and large stockpiles of ore accumulated at some Australian ports. In the latter part of the year, however, shipments increased and a total of 64 million long tons was recorded for 1972. Exports of iron ore totaled were estimated at 52 million tons. The average iron content of Australian ore produced in 1972 was 63.6%.

Production capacity continued to increase. The Robe River project was completed in 1972; the first shipment of sinter feed was made in October, and shipment of pellets began by December. Hamersley Iron Pty. Ltd. expected to complete the Paraburdoo project by yearend; Goldsworthy Mining Ltd. was completing a 40-mile railroad and other facilities to bring the Shay Gap and Sunrise Hill ore bodies into production; and Mt. Newman Mining Co. Pty. Ltd. was also expanding capacity. Australian production capacity for iron ore was probably at least 95 million tons annually by yearend.

Production of iron ore pellets in 1972 was 6.3 million tons, compared with 6.7 million tons in 1971. Completion of the Robe River project increased Australian production capacity for pellets to approximately 11 million tons annually at the end of 1972. The Hamersley company planned to increase pellet capacity by another 600,000 tons annually by mid-1974.

Port facilities at Dampier and Port Hedland were also expanded in 1972, to speed up loading operations and to accommodate ore carriers of up to 150,000 d.w.t. The new port completed at Cape Lambert can also handle 150,000-ton vessels. The largest iron ore cargoes loaded during 1972 at Port Hedland and Dampier were 132,314 long tons and 159,281 long tons, respectively. The largest cargo loaded at either port in 1971 was 111,499 tons.

Exploration of "Mining Area C," about 200 miles south of Port Hedland, was continued by the Goldworthy Co. in 1972. Cyprus Mines Corp., which owns a one-third interest in the company, reported that proven ore reserves in this area exceeded 700 million tons, containing 63% iron.

Devaluation of the U.S. dollar and revaluation of Australian currency were matters of increasing concern to Australian iron ore producers, because the export price of most Australian ore is fixed in U.S. dollars in long-term contracts negotiated with Japanese buyers prior to 1971. Negotiations for upward revisions of these prices were expected to continue in 1973.

Iron ore shipments by Australian producers in 1971 and 1972, in thousand long tons, were reported [3] as follows:

Producer	1971	1972
Hamersley Iron Pty. Ltd.	20,719	22,117
Mt. Newman Mining Co. Pty. Ltd.	18,708	21,443
Goldsworthy Mining Ltd.	6,897	6,465
Broken Hill Pty. Co. Ltd.	12,114	8,891
Savage River Mines	2,193	2,306
Cliffs Robe River Iron Associates	--	1,369
Frances Creek Iron Mining Corp.	949	823
Western Mining Corp. Ltd.	649	610
Total	62,229	64,024

Brazil.—Production and exports of iron ore totaled about 41.4 and 30.8 million long tons, respectively, in 1972. The average iron content of ore produced was reported to be 65%.

[3] Skillings' Mining Review. Various issues, 1972 and 1973.

Production and exports were expected to increase substantially in 1973. Iron ore shipments by Companhia Vale do Rio Doce (CVRD), including shipments for associated companies, were expected to increase to 40 million tons compared with 30.2 million tons in 1972. Minerações Brasileiras Reunidas S.A. (MBR), which shipped 1.5 million tons from three mines near Belo Horizonte in 1972, will begin shipping ore from the Aguas Claras mine in the latter part of 1973. The latter mine will have an initial production capacity of 11.5 million tons annually. Under long-term contracts with Japanese buyers, the combined tonnage of ore scheduled for shipment to Japan by CVRD and MBR in 1973 was 5 million tons more than in 1972. Brazil was expected to become Japan's second largest supplier of iron ore in 1974.

The planned increase in CVRD shipments in 1973 was expected to come mostly from the Piçarrão mine which was opened in mid-1972, plus high-grade fines produced by the new concentrator at the Cauê mine, and increased output from associated companies. At yearend 1972, 14 of 26 concentrating lines were reported to be operating at the Cauê concentrator and the rest were scheduled for completion in 1973. The concentrator will process 20 million tons of crude ore annually by washing and high intensity wet magnetic separation to produce 9 million tons of sinter feed and 5 million tons of pellet feed.

CVRD's second pelletizing plant will be completed at Tubarão in early 1973. The plant's production capacity will be 3 million tons of pellets per year. CVRD shipped 1.9 million tons of pellets in 1972, including 1.3 million tons for export.

Development of iron ore shipping facilities at Tubarão (CVRD) and Guaiba Island (Sepetiba Bay) (MBR) were expected to permit berthing of 250,000 d.w.t. vessels at each port by late 1973. Export shipments from Tubarão in 1972 totaled 27.6 million long tons; the average cargo was 67,000 tons and the largest was 166,000 tons.

Exploration of the Serra dos Carajas iron deposits in Pará was reported by the Ministry of Mines and Energy to have proved reserves of 1.6 billion tons of ore averaging 67% iron. In addition, indicated reserves of 2.9 billion tons and inferred reserves of 6.6 billion tons were announced. A preliminary engineering study of the feasibility of exploiting the deposits was expected to be completed in 1972. The exploration company, Amazônia Mineração S.A., is owned 51% by CVRD and 49% by Cia. Meridional de Mineração, a subsidiary of United States Steel Corp.

Canada.—Total shipments of iron ore (including byproduct ore) in 1972 declined 8.7% compared with those in 1971. Exports declined by 12%, to 29.6 million long tons. The reductions were partly due to low export demand and the Japanese shipping strike in the first half of the year, but they were mainly due to Canadian strikes which halted operations at mines and plants in Labrador and northern Quebec for 2 to 3 months in the summer. Ore shipments from stockpiles at Sept-Îles and Pointe Noire continued for most of the strike period, as did construction of the Mt. Wright project and new concentration and port facilities at Sept-Îles, but expansion of the concentrator at Labrador City and completion of flotation and pelletizing facilities at Sept-Îles was not expected until 1973. The latter plants will increase annual production capacity of the Iron Ore Co. of Canada by 11 million tons of concentrates at Labrador City and by 6 million tons of pellets at Sept-Îles.

The Mt. Wright project of Quebec Cartier Mining Co. (QCM) was expected to be completed on schedule in 1975. Construction of the 75-mile railroad from Lac Jeannine, the new town of Fermont 12 miles northeast of Mt. Wright, and the concentrator buildings at the mine site were well underway by September. By the time that Mt. Wright comes into production, ore reserves at Lac Jeannine are expected to be depleted so that annual production capacity of QCM will be about 16 million tons of concentrates in 1976. It was possible that the Fire Lake iron deposits north of Lac Jeannine may also be developed for production, in which case the Fire Lake ore would probably be processed at Lac Jeannine.

Iron ore shipments from British Columbia were curtailed in 1972 by the Japanese shipping strike. Accumulation of concentrate stockpiles forced Wesfrob Mines Ltd. to cease mine production temporarily in July. Shipments of concentrates by Texada Mines Ltd. were unaffected, however, because the company operates its own ore carrier.

Two producers of byproduct ore, Cominco Ltd. and the Sudbury pyrrhotite plant of Falconbridge Nickel Mines Ltd., ceased production in 1972. Falconbridge also announced plans to close its direct-reduction plant at Sudbury in early 1973. The latter plant had an annual production capacity of 300,000 tons of metallized pellets containing about 92% iron and 1.5% nickel; shipments of pellets were reported to be 29,000 tons in 1972. Also at Sudbury, International Nickel Co. of Canada Ltd. canceled its projected 250,000-ton expansion of iron ore pelletizing capacity because of new antipollution regulations. At Contrecoeur, Quebec, Midland-Ross Corp. was building a prereduction plant for production of 400,000 tons of metallized pellets per year. The plant was being built for the Siderurgie Quebec (Sidbec) and Dominion Steel and Coal Corp.) (Dosco) interests, and was scheduled for completion early in 1973.

Canadian consumption of iron ore was estimated at 11.6 million long tons in 1972, up from 10.8 million tons in 1971. Canadian production capacity for iron ore at yearend was 47.35 million tons annually, including 25 million tons of pellets. Total capacity late in 1973 was expected to be about 60 million tons.

Chile.—Production of iron ore in 1972 was 23% less than in 1971, and exports may have declined even more. The declines appeared to be due to sharply reduced demand for Chilean ore in Japan and the United States in 1972. Imports of iron ore from Chile in 1972, as reported by Japan and the United States, totaled 6.9 million long tons, nearly 30% less than in 1971. Chile exported 10.14 million long tons of iron ore in 1971, of which 98% was destined for Japan and the United States.

The El Laco mine, in northeastern Chile 20 miles from the Argentine border, was expected to begin production early in 1973. No further details were available.

European Economic Community (EEC).—Production of iron ore in the EEC countries declined in 1972, but imports increased and overall consumption of iron ore rose about 7% compared with 1971. Imports of iron ore totaled about 96 million long tons, of which 78 million tons came from foreign sources (principally Sweden, Liberia, and Brazil) and 18 million tons came from France.

Some statistics on consumption of iron ore in the EEC are shown in table 2.

During the 3-year period 1970–72, production of crude and marketable ore in the EEC declined about 7% while total employment declined 14%. During this period, average output of crude ore per man-shift in underground mines rose about 25% in West Germany, 14% in France, 39% in Luxembourg, and 68% in Italy; in open pits, average productivity increased 23% in the eastern (Lorraine) region of France but declined 25% in Luxembourg. Some statistics on the EEC iron mining industry in 1972 are shown in table 3.

Production capacity for crude iron ore in the EEC was estimated at 72.0 million long tons per year in 1972, compared with 103.8 million tons in 1962. Output capacity in 1975 was expected to be 74.3 million long tons.[4]

[4] Commission of the European Coal and Steel Community (ECSC). Investment in the Community Coal Mining and Iron and Steel Industries Report on the 1972 Survey. July 1972, pp. 9–57.

Table 2.—Consumption of iron ore in the EEC, 1970–72

(Thousand long tons)

	1970		1971		1972 [e]	
	Quantity	Fe content	Quantity	Fe content	Quantity	Fe content
In agglomerating plants [1]	88,415	40,796	91,683	41,311	102,400	47,100
In blast furnaces [2]	54,698	26,299	44,706	22,665	42,800	21,800
In steel furnaces	1,501	901	1,240	751	1,300	800
Total [3]	144,614	67,996	137,629	64,727	146,500	69,700

[e] Author's estimate.
[1] Including ore agglomerated at the mines.
[2] Including ore consumed in electric pig iron furnaces.
[3] Excluding pyrite cinder, of which 3.93 million tons was consumed in agglomerating plants and blast furnaces in 1970; 3.11 million tons in 1971; and an estimated 2.46 million tons in 1972.

Source: Statistical Office of the EEC (Luxembourg). Iron and Steel, Bimonthly Statistics. No. 1, 1973, pp. 134–138. 1972 estimates based partly on statistics for first 9 months of year. Source reports quantities in metric tons.

Table 3.—Selected statistics on iron mining industry of the EEC in 1972

(Thousand long tons unless otherwise specified)

	France	West Germany	Luxembourg	Italy	Total EEC
Crude ore mined	53,990	6,020	4,051	829	[1] 65,001
Marketable ore produced	53,155	4,749	4,051	593	[1] 62,659
Average Fe content (%)	30.9	32.3	25.7	39.3	[1] 30.8
Marketable ore shipments [2]	54,275	5,050	4,048	655	[1] 64,139
Ore stocks, Dec. 31 [3]	3,841	1,162	170	407	[1] 5,585
Employment, Dec. 31:					
Total workers [4]	8,748	2,647	897	717	13,009
Total employed [5]	NA	NA	NA	NA	15,862
Productivity: Average crude ore output per man-shift (tons):					
Underground	[6] 37.9	19.0	32.8	12.0	NA
Open pit	[6] 84.9	--	67.7	26.8	NA
Average direct hourly wage [7] (U.S. dollars):					
Underground	[8] $2.14	$2.67	$3.10	$1.86	NA
Open pit and other surface	$1.67	$2.37	$2.74	$1.47	NA

NA Not available.

[1] Total figures exceed sum of individual countries listed; difference may represent data for Belgium.

[2] Including ore shipped to other EEC countries. French shipments included 35.9 million tons to domestic industry and 18.3 million tons to other EEC countries, principally Belgium and Luxembourg.

[3] Mostly crude ore.

[4] Not including apprentices or salaried personnel.

[5] Including 8,348 underground workers, 330 open pit workers, 4,331 other surface workers, 87 apprentices, and 2,766 salaried personnel.

[6] In the eastern mines, which account for about 95% of total French output, productivity figures were 40.7 for underground mines and 266.0 for open pit mines. Corresponding figures for western mines were 17.4 and 11.3, respectively.

[7] As of October 1972. Includes apprentices. U.S. dollar equivalents based on spot exchange rates in each country at end of 3d quarter 1972 (Source OECD (Paris). Principal Economic Indicators. December 1972, pp. 68–90).

[8] Eastern mines only.

Principal source: Statistical Office of the European Communities (Luxembourg). Iron and Steel, Bimonthly Statistics. No. 1, 1973, pp. 182–191. (Source reports quantities in metric tons.)

Finland.—Construction of the concentrator for the Rautavaara underground iron mine near Kolari was started in 1972. The plant was expected to begin production in 1974 at the rate of 400,000 to 500,000 tons of magnetite concentrate per year. The concentrate will be sent to the State Steelworks at Raahe.

Production of iron ore from the Leveäselkä deposit near Raajärvi began in 1972. The ore was concentrated at the Raajärvi plant.

An agreement between the Governments of Finland and the Soviet Union, for joint development of iron deposits in the Kostomus area of Soviet Karelia, was likely to be signed in 1973. The Finnish Ministry of Transport reportedly began engineering studies for a 37-mile railroad line between Kontiomaki and the Soviet border in 1972. If the proposed Kostomus project is carried out, production of concentrates (possibly pelletized) would probably begin sometime after 1976. Part of the output would be consumed in Finland and part would be exported from Finnish ports. Imports of iron ore by Finland amounted to 771,000 tons in 1972, but ore requirements are expected to increase by about 1 million tons per year in 1976 when the new blast furnace at Raahe is scheduled to begin production.

Gabon, Guinea, and Ivory Coast.—The possibility of exploiting deposits of iron ore in these countries continued to be investigated in 1972, but owing to the difficulty in obtaining the necessary financing no firm plans for development were announced by yearend. In Gabon, development of the Bélinga deposits, which reportedly contain more than 500 million tons of proved ore averaging 64% Fe and 0.12% phosphorus, would require construction of a 350-mile railroad in addition to port and mine facilities. In Guinea, exploitation of the Nimba and Simandou deposits would require construction of a 450-mile railroad and port facilities if the Government decides that the ore should be transported wholly within Guinea, but since the Nimba deposits (potentially, 200 million tons averaging 47% Fe) lie within 20 miles of already-established ore-hauling railroad in Liberia, these might be developed if the necessary agreements can be worked out between the Governments of the two countries and the Liberian-American-Swedish Minerals Co. (LAMCO), which operates the Liberian railroad, to transport the ore to Buchanan. Simandou deposits, about

50 miles north of Nimba, contain about 350 million tons of potential reserves averaging 64% iron. In Ivory Coast, development of low-grade iron deposits at Mount Khowayo, about 60 kilometers east of the Liberian border, would require construction of a 150-mile railroad (or pipeline), port facilities, and beneficiating and pelletizing plants. Large reserves reportedly occur in the Khowayo area, averaging between 35% and 40% iron.

India.—Production and exports of iron ore in 1972 increased by 2% and 5%, respectively, compared with those of 1971. Exports in 1972 totaled 21.14 million long tons, of which 83% was destined for Japan. Domestic consumption of iron ore was reported at 10.7 million long tons, up 2% from 1971.

Expansion of production and transportation facilities continued to be slow, but government plans to increase exports to 51.0 million long tons in 1975 were unchanged from the previous year. To achieve this level of exports, the outloading capacity of Indian ports will have to be more than twice the estimated total capacity in 1972 (24.3 million tons) and nearly 50% more than the total capacity planned by the end of 1974 (34.6 million tons). An additional 4-million-ton increase in exports may be realized if the Kudremukh project and its slurry pipeline were built, but government approval for the project had not been received by yearend. In 1972, India continued to rank second to Australia in exports of iron ore to Japan, but Brazil was expected to become Japan's second largest supplier in 1974.

Expansion of the Bailadila mine, to a productive capacity of 10 million tons annually by 1976, was reportedly on schedule in 1972 but expansion of the Kiriburu mine was delayed. Annual production capacity in 1972 was 4 million tons at Bailadila and 3.3 million tons at Kiriburu. The pelletizing plant constructed by Tata Iron and Steel Co. Ltd. at Noamundi, with a production capacity of 1 million tons annually, was reported to be in production by the end of 1972. In Goa, pelletizing facilities of Chowgule and Co. Ltd. were reportedly expanded in 1972, but shipments of pellets (485,000 tons) were about the same as in previous years.

Japan.—Imports of iron ore by Japan in 1972 exceeded 100 million tons for the third straight year. Imports in 1972 totaled 110 million long tons (113 million tons in 1971), with Australia and India supplying 43% and 16%, respectively. Supplies from other countries, as reported in Japanese trade statistics, included (in million long tons) 9.2 from Brazil, 6.8 from Peru, 6.6 from Chile, and more than 2 million tons each from six other countries. Imports of iron concentrates produced from beach sand deposits in New Zealand, Indonesia, and Panama totaled 1.4 million tons, although the actual total may have exceeded 2 million tons due to imports of similar ores from the Philippines.

Domestic production of iron ore pellets was 3.86 million long tons, compared with 4.17 million tons in 1971. Domestic supplies of pellets totaled 14.2 million tons in 1972, including 10.3 million tons of purchased pellets which were probably mostly obtained from Australia and Peru. Consumption of foreign and domestic iron ores in 1972, as reported by the Japan Iron and Steel Federation, totaled approximately 117.4 million long tons, including iron ore (93.2), foreign pellets (9.0), iron sands (2.9), ferruginous manganese ore (1.3), pyrite cinder (0.5), and "other" (domestic) materials (10.5). "Other" material may consist mainly of plant dust and scale, and domestically produced pellets.

New pelletizing plants under construction in 1972 were expected to increase Japanese production capacity for pellets to about 9 million tons annually by early 1973. At the Kakogawa Works of Kobe Steel Corp., a new plant with annual output capacity of 2 million tons was reportedly operating by the end of 1972. At the Hirohata Works of Nippon Steel Corp., a 2.5-million-ton plant was scheduled for completion in January 1973. Part of the feed to the Hirohata plant was to be iron ore concentrates shipped in slurry form from Peru. At the Mizushima Works of Kawasaki Steel Corp., a $10 million plant for pelletizing 1,000 tons per day of in-plant dust and sludge was scheduled for completion in March 1973. Pellets produced by the latter plant were expected to contain about 75% iron. Kawasaki was also reported [5] to have closed the last remaining pellet plant at the company's Chiba Works, where a new 7,000-ton-per-day sinter plant was under

[5] Metal Bulletin (London). No. 5679, Feb. 29, 1972, p. 26.

construction. Total production capacity of the three pellet plants closed at Chiba since November 1969 was about 1.7 million tons per year.

Liberia.—Production of iron ore in 1972 was approximately the same as the previous year, but production of iron ore pellets increased 19%, and total exports increased nearly 10% to 22.4 million long tons. The increased output of pellets was due to the first full year of production at the Bong Mining Co. plant. Of total Liberian production in 1972, lump ore comprised 22%, pellets 16%, and the remainder consisted of fines.

Of total exports, shipments by LAMCO accounted for about 50%; Bong Mining Co., 24%; National Iron Ore Co., (NIOC) 17%; and Liberia Mining Co. (LMC) for the remainder. Seventy-one percent of the exports was destined for EEC countries, principally West Germany and Italy. About 2.5 million tons each went to the United States and Japan. The average cargo shipped from Buchanan in 1972 by LAMCO was 52,000 tons, while at Monrovia, the average was 53,000 tons for Bong and 33,000 tons for NIOC.

LAMCO's mining project at Mt. Tokadeh was completed in 1972 and the first shipment of concentrates was made shortly after the end of the year. Reserves of easily-concentrated ore at this property were stated to be about 100 million tons, averaging 53% iron. LAMCO expected to produce 12.1 million long tons of ore products in 1973, including 1 million tons from Mt. Tokadeh. The company continued explorations in the Mt. Tokadeh-Beeton-Yuelliton area, completing 6,000 feet of diamond-drilling and 2,900 feet of tunneling. A new crushing plant will be installed at Buchanan by early 1974, to reduce lump ore to 30 millimeters diameter.

The LMC ore body at Bomi Hills was expected to be exhausted by the end of 1973. LMC continued to explore deposits at Bie Mountain, 22 miles northwest of the Bomi mine.

NIOC continued to expand production capacity at Mano River, with completion of the Mano II project scheduled for early 1973. Total ore reserves were estimated by company officials in 1972 to be at least 200 million tons. An option to acquire control of the Wologisi iron deposits by a group of Japanese companies by May 1, 1972, was not exercised. No further developments were reported by yearend.

Malaysia.—Production of iron ore continued to fall rapidly. Output in 1972 was 45% less than in 1971, and it was possible that no ore would be mined in 1974 as no contracts for export to Japan were indicated beyond 1973. Practically all Malaysian output has been exported to Japan. Exports to Japan in 1972 were estimated at 350,000 tons, and the only reported contract for 1973 was for 180,000 tons from the Sungueygau mine of Sharnkat Brimca Mining Co. Ltd.

Mexico.—Contracts for construction of two pellet plants were signed in 1972. Arthur G. McKee & Co. of Cleveland will design and construct a circular-grate pelletizing plant at the La Perla mine in Chihuahua for Altos Hornos de Mexico S.A. Production capacity of the plant will be 600,000 tons of pellets per year, with completion scheduled by the spring of 1974.

Consorcio Minero Peña Colorada S.A. contracted with Lurgi Chemie und Hüttentechnik G.m.b.H. for construction of a pellet plant at Manzanillo on the west coast. Production capacity of the plant will be 1.5 million tons of pellets per year beginning in 1974. Ore feed for the plant was to be supplied by a 30-mile slurry pipeline from mines in Colima.

Shipments of pellets in 1972 by Las Encinas S.A. totaled 1.29 million long tons, 50% more than shipments in 1971. About 75% of shipments in 1972 went to the Monterrey and Puebla plants of Hojalata y Lámina S.A. and the remainder to Tubos de Acero de Mexico, S.A. in Vera Cruz. Shipments of iron ore in 1972 by La Perla Minas de Fierro S.A. and Cía Fundidora de Fierro y Acero de Monterrey S.A. totaled 3.09 million long tons.

Morocco.—Production of iron ore in 1972 was 62% less than in 1971. Most of the output was reportedly stockpiled, as preparations were made to begin processing the ore in the new Uixan concentrator and pelletizing plant which have been under construction since 1970. Production of iron ore pellets, at an annual rate of about 850,000 tons, was expected to start during 1973. Concentration of the magnetite ore is expected to yield about 80,000 tons of byproduct pyrite per year.

Exports of iron ore in 1972 totaled about 325,000 long tons, mostly destined for West Germany and Czechoslovakia.

An agreement settling the border dispute between Morocco and Algeria and providing for joint exploitation of iron deposits at Gara-Djebilet was reportedly signed June 15, 1972, by the Governments of both countries. The Gara-Djebilet deposits are located 130 kilometers southeast of Tindouf, Algeria.

New Zealand.—The sharp increase in production of iron ore in 1972 was due to the first full year of production at the Waipipi iron-sand project on the west coast of North Island. Shipments of titaniferous magnetite concentrate from the Waipipi operation totaled 942,000 tons in 1972. All of the concentrate was shipped in the form of slurry, using the Marconaflo system. The Waipipi project is operated and 75% owned by the Marcona Corp. Reserves of beach sand, averaging about 11% iron, reportedly totaled more than 300 million tons at the end of 1972.

Norway.—Exports of iron ore in 1972 totaled about 2.9 million long tons including 1.2 million tons of pellets. The principal destinations continued to be West Germany and the United Kingdom. A/S Sydvaranger, the major Norwegian producer, increased shipments to more than 2.5 million tons but prices were reportedly lower than in 1971.

Construction of a second pelletizing line was begun by A/S Sydvaranger at Kirkenes in 1972. Completion of this project will increase the company's production capacity for pellets to about 2.7 million tons per year by the end of 1974. The company contracted with the British Steel Corporation to deliver 6 million tons of pellets during a 6-year period beginning in 1973.

Shipping capacity for iron ore at the ports of Kirkenes and Narvik was increasing in 1972. At Kirkenes, two vessel cargoes of 137,500 tons each were loaded during the year; the largest ship previously accommodated was about 75,000 d.w.t. At Narvik, which is the main shipping port for Swedish iron ore, the largest single cargo loaded in 1972 was about to be 86,000 long tons. The port was being developed to accommodate vessels of up to 300,000 d.w.t. by 1975.

Panama.—Production of iron ore concentrates from Pacific beach sand deposits in the Balboa district may have begun late in 1971. The first shipment of concentrates was made in February 1972. The operating company, Hierro Panama S.A., was jointly owned by Sumitomo Shoji Kaisha Ltd. of Japan and Minera de Chame S.A. of Panama. A contract was negotiated by Sumitomo in 1970 for export to Japan of about 1.5 million tons of concentrate during a 6-year period.

The beach sand reserves were estimated to contain 2.5 million tons of concentrate averaging 62% to 63% Fe and about 7% TiO_2.

Peru.—Shipments of iron ore products in 1972 by Marcona Mining Co. totaled 9,096,000 long tons, of which 8,900,000 tons were exported and 196,000 tons were shipped for consumption in Peru. Total shipments included 3,335,000 tons of pellets and 382,000 tons of iron ore slurry plus filter cake. An estimated 75–80% of export shipments were destined for Japan. Vessel shipments to Japan included one cargo of 141,732 long tons, consisting of 96,525 tons of slurried pellet feed discharged at Hirohata and 45,207 tons of sinter feed unloaded at Oita. Total shipments of iron ore products from San Nicolas by Marcona reached the 100-million-ton mark in March 1971.

Late in 1972, a group of five Japanese steel companies contracted with Marcona for delivery of 22 million tons of iron ore pellets over a 7-year period beginning in 1975. The Japanese group will lend Marcona $66 million for construction of new pelletizing facilities which will have an initial production capacity of 3.5 million tons of pellets per year in 1975. Production capacity of the existing pellet plant at San Nicolas was raised to 4 million tons per year by early 1972.

Philippines.—Iron ore was produced by eight companies in 1972. Philippine Iron Mines, Inc., produced 32% of the total output from magnetite-hematite deposits in Luzon, where the product was processed for pelletizing and export by Pellet Corp. of the Philippines, a Japanese-owned company. Titaniferous magnetite concentrates, produced by four companies from beach sand deposits in Luzon and Leyte, accounted for 58% of total output, and most of the remaining 10% was byproduct magnetite produced by two companies from copper ore milling operations in Cebu and

Luzon. About 12,000 tons of lump ore were produced at the Sibuguey mine in Mindanao by Zambales Base Metals, Inc. The latter mine was closed in July 1972.

Exports of iron ore totaled 2.27 million dry long tons in 1972, 7% more than exports in 1971. Practically all exports were destined for Japan. Japanese contracts called for export of a similar quantity in 1973.

South Africa, Republic of.—Although a final decision was not made by the Government in 1972 to proceed with the Saldanha Bay iron ore export project, the Government-owned South African Iron and Steel Industrial Corp. (ISCOR) announced plans in midyear to expand productive capacity of the Sishen mine by 6.2 million tons annually by 1980. Tenders were also invited for construction of an ore-blending and loading plant at Sishen. Cost of the expansion was estimated at about $30 million.

The Saldanha Bay project would require construction of a 530-mile railroad to the Sishen mine, a deepwater port and loading facilities at an estimated total cost of about $600 million. As an alternative to the Saldanha project, private producers advocated expansion of existing railway haulage capacity to Port Elizabeth and construction of a bulk carrier terminal at St. Croix Island. Cost of this project was estimated to be less than half of that for the Saldanha scheme. The economic viability of either project appeared to depend to a large extent on long-term export contracts with Japanese importers of iron ore, but the necessary contracts had not been signed by yearend.

In other developments, Palabora Mining Co. Ltd. was considering increasing production of high-grade byproduct magnetite concentrate to 4 million tons annually. In October, the company contracted with the Bechtel Corp. to study the feasibility of transporting this quantity of concentrate by a 200-mile slurry pipeline to Lourenço Marques or Punta de Vela on the Mozambique coast. Palabora currently produces about 1 million tons of the concentrate annually, mostly for export to Japan but reportedly stockpiles an additional 4 million tons of rough concentrate at the mine site.

South African exports of iron ore in 1972 totaled 4,985,000 long tons, about 9% less than in 1971.

Sweden.—Compared with 1971, Swedish production of iron ore declined 3.6% in 1972 but exports increased 5.5% to 27.2 million long tons. Domestic shipments declined 8.6% to 4.09 million tons. Mine stocks of iron ore at yearend totaled approximately 8.7 million tons, an increase of 1.38 million tons from a year earlier. Due to the high level of stocks, production of ore in 1973 was not expected to increase appreciably from the 1972 level.

Of total exports, 59% was lump ore, 21% was unagglomerated fines, and the remainder consisted almost entirely of iron ore pellets. The principal destinations of export shipments continued to be West Germany, Belgium-Luxembourg, and the United Kingdom.

The average f.o.b. value of ore exported in 1972 increased less than 3% in terms of Swedish krona, compared with the average value in 1971, but because of devaluation of the U.S. dollar and revaluation of the krona since 1971, the increase in dollar terms amounted to more than 10%. This weakened the competitive position of Swedish ore, especially in the West European market, relative to Australian and other foreign ores for which contracts were based on dollar values. Also, the use of larger ore carriers was reducing transoceanic freight costs. Consequently, late in 1972, Swedish prices for 1973 deliveries were reduced 12% to 15% for high-phosphorus ores and 6% to 10% for other ores. Gränges AB reported an average reduction in price of 7% for 1973 deliveries.

Turkey.—Plants for concentrating and pelletizing iron ore from low-grade magnetite/hematite deposits in the Divriği area were expected to be completed in 1975. Cost of the project was estimated at about $30 million, including $14 million in foreign exchange. Planned annual rates of production were 1.6 million tons of concentrates averaging 63.5% iron, and about 1.2 million tons of pellets.

The Divriği mines currently produce about 1 million tons per year of direct-shipping magnetite ore which is shipped by rail to state-owned blast furnaces at Karabük. Most of the planned output of concentrate and pellets may be shipped to the Ereğli Steelworks on the Black Sea coast.

United Kingdom.—Domestic production of iron ore continued to decline in 1972. Output was 12% less than in 1971. Imports of iron ore in 1972 (17.08 million long tons) were slightly less than in the previous year, while consumption of iron ore was down 3%, to 26.1 million long tons. The share of domestic ore in total consumption in 1972 was 34.6% on a gross-weight basis, but because of its low iron content (average 28%), domestic ore was estimated to have supplied only about 20% of the total iron units in ore consumed. Canada and Sweden supplied a total of 43% of the iron ore imported in 1972, and another 37% was supplied by Brazil, Mauritania, Venezuela, and Australia. More than 1 million tons of iron ore were also imported from the U.S.S.R. in 1972.

A new iron ore import terminal at Immingham, and an ore-blending plant at Scunthorpe, were probably completed in 1972 by the British Steel Corp. (BSC). Both facilities were planned for completion in mid-1972, as part of the "Anchor" project of BSC to modernize and expand iron and steelmaking operations at Scunthorpe. Under the project, the blast-furnace burdens at Scunthorpe will be changed from domestic ore to mixed domestic and imported ore. Earlier, BSC had made an agreement with British Rail for hauling 6 million tons of iron ore per year from Immingham to Scunthorpe, a distance of 23 miles. The Immingham terminal was planned to initially accommodate ore carriers of 65,000 d.w.t.

BSC also continued construction of the $35 million Redcar iron ore terminal at Teesside. Completion was expected by March 1973. This terminal will accommodate ore carriers of up to 150,000 d.w.t. BSC also planned to go ahead with construction of an ore terminal at Hunterston on the Firth of Clyde in western Scotland. The Hunterston terminal was planned to initially accommodate 250,000 d.w.t. vessels.

U.S.S.R.—Soviet production of crude iron ore in 1972 was estimated at about 379 million long tons. This assumes a ratio of 1.85 tons of crude ore for each ton of usable ore produced. Soviet plans were to produce 250 million long tons of usable ore in 1975, from 470 million tons of crude ore. About 80% of all usable ore produced in 1972 came from open pit mines and 20% from underground mines. About two-thirds of the usable ore output was concentrate. Average iron content of usable ore was estimated to be 59%, compared with 56.7% in 1965.

Production of iron ore pellets in 1972 was not reported but may have exceeded 13.8 million long tons. Output in 1970 and 1971 was reported[6] to be 10.6 million metric tons and 13.5 million metric tons, respectively. In October 1972, the (British) Davey-Ashmore Group reported the commissioning of an iron ore pelletizing plant at Krivoy Rog in the Ukraine. The plant has an annual production capacity of about 4 million tons of pellets and is fueled by natural gas. The plant was designed by Lurgi Chemie und Hüttentechnik G.m.b.H. of West Germany.

Soviet exports of iron ore in 1972 totaled 37.8 million long tons, an increase of 1.9 million tons compared with exports in 1971. Most exports of iron ore were destined for Czechoslovakia, Poland, and other East European countries, but the United Kingdom, Italy, and Japan each reported receipts of more than 1 million tons and imports of 349,000 tons were reported by West Germany.

Venezuela.—Shipments of iron ore by Orinoco Mining Co. and Iron Mines Co. of Venezuela in 1972 totaled 16,256,000 long tons, nearly 15% less than shipments in 1971. Shipments by Orinoco were reduced by about 2 million tons while those from El Pao were down by 740,000 tons. All but about 8,000 tons were exported, mainly to the United States.

Expansion of beneficiation facilities at Puerto Ordaz by Orinoco Mining Co. was continued in 1972. The project was designed to expand iron ore shipments to about 23.2 million long tons per year by the end of 1973. The company's direct-reduction plant at Puerto Ordaz was still undergoing break-in operations in 1972.

Bethlehem Steel Corp. authorized construction of a new crushing and washing plant at the El Pao mine. The plant will have an annual production capacity of about 3.6 million long tons of beneficiated ore products.

---

[6] United Nations, Economic Commission for Europe (ECE). Steel Committee, WP.4/Working Paper No. 13, Add. 7, June 7, 1972.

TECHNOLOGY

The size and productive capacity of iron ore mining, processing, and handling equipment continued to increase in 1972. At large mining operations in the United States and elsewhere, the use of power shovels with bucket capacities of 10- to 14-cubic yards, rotary drills for 10- to 15-inch blastholes, and trucks of 100- to 150-ton haulage capacity was common although many units of smaller capacity were also in use. A 16-yard shovel was being evaluated on the eastern Mesabi range, as were trucks of 200-ton haulage capacity at the Minntac and Mt. Tom Price mines in Minnesota and Australia. At taconite operations on the Mesabi range, blasthole drilling at the Butler, National, and Minntac mines was done mainly by rotary drills, while jet-piercers were used principally at the Thunderbird, Erie, and Peter Mitchell mines. At underground mines in Pennsylvania (Grace) and Missouri (Pea Ridge), load-haul-dump units with bucket capacities of 5- to 8-cubic yards were in use. In the large underground mines in northern Sweden, trucks of 40- to 80-tons haulage capacity were used. Front-end loaders with 13-cubic-yard capacities were scheduled to be used at the Tilden (Michigan) and Mt. Wright (Quebec) mines which are now being developed.

In materials handling, the capacity of loading and unloading systems at iron ore shipping and receiving ports was also being increased to handle larger stockpiling requirements and to accommodate the larger ore carriers coming into service. Bucket-wheel stacker/reclaimers were being installed at many of these facilities. Traveling shiploaders with individual capacities of 6,000 to 8,000 long tons per hour (ltph) were installed or under construction at the ports of Sept-Îles, Dampier, Port Hedland, and Sepetiba Bay in 1972, and a slewing-boom loader with reported capacity of 16,000 ltph will be installed at Tubarão in 1973. The largest ship unloaders in the United States were being installed at the Sparrows Point plant of Bethlehem Steel Corp., where three traveling clamshell bucket unloaders will have a combined free-digging capacity of about 5,800 ltph. The unloaders were reportedly designed to service vessels of up to 160,000 d.w.t., and are integrated with two bucket-wheel stacker/reclaimers with 220-foot booms. Similar clamshell unloaders were under construction or being installed at the Chiba and Mizushima plants of Kawasaki Steel Corp. in Japan, and at the Taranto plant of Italsider S.p.A. in Italy for vessels up to 250,000 d.w.t.

In ore milling and concentration, installation of a fine-screening circuit in the Pea Ridge concentrator was reported by Meramec Mining Co. to have reduced the average silica content of pellets produced to less than 3%. Fine-screening was also reported to have increased production capacity by 10% at the Fairlane concentrator of Eveleth Taconite Co. Autogenous grinding mills to be installed in large concentrators now under construction include six 27-foot-diameter units at the Tilden project, six 32-foot-diameter units at the Mt. Wright project, and at least two 34-foot-diameter mills at the Carol Lake plant of the Iron Ore Co. of Canada. Flotation cells of 500-cubic-foot capacity were being installed at the Sept-Îles and Tilden concentrators. For the Tilden pelletizing plant, Allis Chalmers was building a rotary kiln 160 feet long and 25 feet in diameter, reportedly the largest of its type in the United States. In Brazil, the Cauê concentrator, which will use 26 Jones high-intensity magnetic separators, was 50% completed by yearend and will be in production by 1974. A Carpco high-intensity separator was reportedly being tested at the Wabush Mines concentrator in 1972.

The demand for pelletized iron ore continued to be strong. An estimated 14 million tons of new plant capacity was installed worldwide in 1972 and an estimated 16 million tons of additional capacity was scheduled for completion in 1973. The Robe River plant, which started production late in 1972, was believed to be the only major plant to pelletize goethite or limonitic ore; all other pellet plants, with the possible exception of a small plant at Skopje, Yugoslavia, use magnetite or hematite feed.

Interest in prereduced iron ore also remained high, but improvements in technology appeared to be needed before large-scale production could be realized. Production in some cases appeared to be well below the rated capacity of existing plants, and Falconbridge Nickel Mines Ltd. announced that its new Sudbury plant would be closed early in 1973. In Australia, production of metallized ore by the Hamersley Iron Pty. Ltd. was still in the pilot plant stage. However, Armco Steel Corp. completed its ore reduction plant at Houston, Tex., in 1972, and completion of a 400,000-ton-per-year plant at Contrecoeur, Quebec, by Midland-Ross Corp. was expected early in 1973.

The Bureau of Mines continued research on beneficiation of low-grade, nonmagnetic iron ores of the taconite type, partly to find more economic methods of concentration which may permit commercial development of additional low-grade resources in the Lake Superior region. Bureau research on Michigan ores of this type, in cooperation with the Cleveland-Cliffs Iron Co., was largely responsible for the Tilden project now under construction on the Marquette range. Research also continued on dephosphorization of calcareous iron ore, production of iron ore superconcentrates [7] and pellets,[8] metallization of pellets and direct reduction of iron ore,[9] and raising the iron content of, and pelletization, of blast- and steel-furnace dusts for recycling.[10] A paper on the development and use of blasting agents and slurries was also published.[11]

---

[7] Tippin, R. B. Production of Magnetic Superconcentrates by Cationic Flotation. Trans. Soc. Min. Eng. AIME, v. 252, March 1972, pp. 53–61.

[8] Nigro, J. C., R. K. Zahl, and C. Prasky. The Effect of Dolomitic Lime Upon Magnetic Taconite Pellets. Soc. Min. Eng. AIME, Birmingham, Ala., Meeting, Oct. 18–20, 1972.

[9] Schluter, R. B., and P. L. Ruzzi. Effect of Preheating Upon Metallization of Iron Ore Pellets. BuMines RI 7612, 1972, 22 pp.

Davis, E. G., and I. L. Feld. Flash Reduction of Iron Ore. BuMines RI 7627, 1972, 10 pp.

Nigro, J. C., T. D. Tiemann, and C. Prasky. Kinetics of CO Reduction of Hematite to Magnetite and the Effect of Silica. BuMines RI 7720, 1973, 43 pp.

Davis, E. G., J. O. Crabtree, and I. L. Field. Continuous Gaseous Direct Reduction Low-Grade Iron Ores in a Fluid-Bed Reactor. BuMines RI 7622, 1972, 19 pp.

[10] Colombo, A. F. Upgrading the Iron Content of Blast Furnace Dusts by Coke Flotation. Ironmaking Pro., Met. Soc. AIME, Chicago, v. 31, 1972, pp. 320–328.

Barnard, P. G., A. G. Starliper, W. M. Dressel, and M. M. Fine. Recycling of Steelmaking Dusts. BuMines TPR 52, February 1972, 10 pp.

[11] Dick, R. A. The Impact of Blasting Agents and Slurries on Explosives Technology. BuMines IC 8560, 1972, 44 pp.

Table 4.—Employment at iron ore mines and beneficiating plants, quantity and tenor of ore produced and average output per man by district and State, in 1972

District and State	Employment: Average number of men employed (thousands)	Employment: Time employed: Average number of days	Employment: Time employed: Total man shifts (thousands)	Employment: Time employed: Man hours: Average per shift	Employment: Time employed: Man hours: Total (thousands)	Production: Crude ore (thousand long tons)	Production: Usable ore (Thousand long tons)	Production: Usable ore: Iron contained[1] (Thousand tons)	Production: Usable ore: Iron contained[1] Percent (natural)	Average per man: Crude ore: Per shift	Average per man: Crude ore: Per hour	Average per man: Usable ore: Per shift	Average per man: Usable ore: Per hour	Average per man: Usable ore: Iron contained: Per shift	Average per man: Usable ore: Iron contained: Per hour
Lake Superior:															
Michigan	2	325	772	8.0	6,175	26,919	11,664	7,332	62.9	34.87	4.36	15.11	1.89	9.50	1.19
Minnesota	8	323	2,432	8.0	19,469	126,099	48,998	29,496	60.2	51.85	6.48	20.15	2.52	12.13	1.52
Wisconsin	(2)	339	48	8.0	388	2,477	888	578	65.1	51.60	6.38	18.50	2.29	12.04	1.49
Total or average[3]	10	324	3,253	8.0	26,031	155,495	61,550	37,406	60.8	47.80	5.97	18.92	2.36	11.50	1.44
Southeastern States: Alabama, Georgia, North Carolina	(2)	245	43	9.5	408	1,280	433	207	47.8	29.77	3.14	10.07	1.06	4.81	.51
Northeastern States: New York and Pennsylvania	1	247	336	8.0	2,691	6,818	2,612	1,678	64.2	20.29	2.53	7.77	.97	4.99	.62
Western States: Missouri, Montana, Utah, Wyoming	2	301	560	8.0	4,483	14,376	6,595	4,017	60.9	25.67	3.21	11.78	1.47	7.17	.90
Other western States[4]	1	235	246	8.0	1,975	9,678	3,934	2,341	59.5	39.34	4.90	15.99	1.99	9.52	1.19
Total or average[3]	3	277	806	8.0	6,457	24,054	10,529	6,358	60.4	29.84	3.73	13.06	1.63	7.89	.98
Grand total or average[3]	14	306	4,438	8.0	35,587	187,648	75,124	45,649	60.8	42.28	5.27	16.93	2.11	10.29	1.28

[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, Idaho, Nevada, New Mexico, and Texas.

Table 5.—Crude 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	1971					1972				
	Number of mines	Hematite	Limonite	Magnetite	Total quantity [1]	Number of mines	Hematite	Limonite	Magnetite	Total quantity [1]
Lake Superior:										
Michigan	7	W	--	W	27,017	5	W	--	W	26,919
Minnesota	32	29,426	--	99,917	129,343	18	23,053	--	103,046	126,099
Wisconsin	1	--	--	2,308	2,308	1	--	--	2,477	2,477
Total reportable	40	29,426	--	102,225	158,668	24	23,053	--	105,523	155,495
Southeastern States:										
Alabama	3	--	1,228	--	1,228	3	--	909	--	909
Georgia and North Carolina	3	--	W	W	529	3	--	W	W	371
Total reportable	6	--	1,228	--	1,757	6	--	909	--	1,280
Northeastern States: New York and Pennsylvania	5	--	--	7,787	7,787	4	--	--	6,818	6,818
Western States:										
Arizona	1	16	--	--	16	1	W	--	--	(2)
Missouri	2	--	--	4,458	4,458	2	--	--	4,703	4,703
Montana	1	--	--	14	14	1	--	--	9	9
Utah	4	W	--	W	4,240	4	W	--	W	4,828
Wyoming	3	W	--	W	4,232	3	W	--	W	4,836
Other [3]	12	W	W	W	15,223	13	W	W	W	9,678
Total reportable [1]	23	16	--	4,472	28,184	24	--	--	4,712	24,054
Total withheld	--	17,552	4,375	29,316	(4)	--	12,045	3,948	30,639	(4)
Grand total [1]	74	46,994	5,603	143,800	196,397	58	35,097	4,858	147,693	187,648

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] Included with "Other."
[3] Includes Arizona (1972), California, Colorado, Idaho, Nevada, New Mexico, and Texas.
[4] Total withheld data included with "Total quantity" for each respective district or State.

Table 6.—Crude iron ore mined in the United States, by district, State and mining method

(Thousand long tons and exclusive of ore containing 5% manganese)

District and State	1971			1972		
	Open pit	Under-ground	Total quantity [1]	Open pit	Under-ground	Total quantity [1]
Lake Superior:						
Michigan	24,203	2,814	27,017	24,231	2,688	26,919
Minnesota	129,343	--	129,343	126,099	--	126,099
Wisconsin	2,308	--	2,308	2,477	--	2,477
Total reportable [1]	155,855	2,814	158,668	152,807	2,688	155,495
Southeastern States:						
Alabama	1,228	--	1,228	909	--	909
Georgia and North Carolina	529	--	529	371	--	371
Total reportable	1,757	--	1,757	1,280	--	1,280
Northeastern States: New York and Pennsylvania	W	W	7,787	W	W	6,818
Western States:						
Arizona	16	--	16	W	--	W
Missouri	--	4,458	4,458	--	4,703	4,703
Montana	14	--	14	9	--	9
Utah	4,240	--	4,240	4,828	--	4,828
Wyoming	W	W	4,232	W	W	4,836
Other [2]	W	W	15,223	W	W	9,678
Total reportable [1]	4,270	4,458	28,184	4,837	4,703	24,054
Total withheld	23,264	3,981	(3)	18,157	3,175	(3)
Grand total [1]	185,145	11,252	196,397	177,082	10,566	187,648

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 (1972), California, Colorado, Idaho, Nevada, New Mexico, and Texas.
[3] Total withheld data included with "Total quantity" for each respective district or State.

Table 7.—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	1971			1972		
	Direct to consumers	To beneficiating plants	Total quantity [1]	Direct to consumers	To beneficiating plants	Total quantity [1]
Lake Superior:						
Michigan	1,439	26,267	27,706	4,271	148,954	27,058
Minnesota	3,335	125,519	128,853			126,166
Wisconsin	--	2,308	2,308	--	2,477	2,477
Total reportable	4,774	154,094	158,868	4,271	151,431	155,702
Southeastern States:						
Alabama	--	1,228	1,228	--	909	909
Georgia and North Carolina	--	529	529	--	371	371
Total reportable	--	1,757	1,757	--	1,280	1,280
Northeastern States: New York and Pennsylvania	--	7,772	7,772	--	6,702	6,702
Western States:						
Arizona	16	--	16	(2)	--	(2)
Missouri	--	4,497	4,497	--	4,726	4,726
Montana	14	--	14	9	--	9
Utah	W	W	4,277	W	W	4,869
Wyoming	W	W	4,232	W	W	4,836
Other [3]	389	14,142	14,531	283	9,697	9,980
Total reportable	419	18,639	27,566	291	14,423	24,420
Total withheld	1,278	7,231	(3)	1,311	8,394	(3)
Grand total [1]	6,470	189,492	195,962	5,873	182,230	188,103

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] Included with "Other."
[3] Includes Arizona (1972), California, Colorado, Idaho, Nevada, New Mexico, and Texas.
[4] Total withheld data included with "Total quantity" for each respective district or State.

Table 8.—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	1971 Hematite	1971 Limonite	1971 Magnetite	1971 Total quantity [1]	1972 Hematite	1972 Limonite	1972 Magnetite	1972 Total quantity [1]
Lake Superior:								
Michigan	W	--	W	11,919	W	--	W	11,664
Minnesota	17,513	--	33,771	51,283	14,452	--	34,546	48,998
Wisconsin	--	--	832	832	--	--	888	888
Total reportable	17,513	--	34,603	64,034	14,452	--	35,434	61,550
Southeastern States:								
Alabama	--	351	--	351	--	311	--	311
Georgia and North Carolina	--	W	W	176	--	W	W	122
Total reportable	--	351	--	527	--	311	--	433
Northeastern States: New York and Pennsylvania	--	--	3,158	3,158	--	--	2,612	2,612
Western States:								
Arizona	16	--	--	16	W	--	--	(2)
Missouri	--	--	2,642	2,642	--	--	2,684	2,684
Montana	--	--	14	14	--	--	9	9
Utah	W	--	W	1,715	W	--	W	1,872
Wyoming	W	--	W	1,809	W	--	W	2,030
Other [3]	W	W	2,836	6,133	W	W	3,056	3,933
Total reportable [1]	16	--	5,492	12,328	--	--	5,749	10,529
Total withheld	9,817	1,057	8,042	(4)	7,143	873	8,549	(4)
Total all States [1]	27,345	1,408	51,294	80,047	21,595	1,184	52,344	75,124
By product ore [5]	--	--	--	715	--	--	--	310
Grand total [1]	27,345	1,408	51,294	80,762	21,595	1,184	52,344	75,434

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] Included with "Other."
[3] Includes Arizona (1972), California, Colorado, Idaho, Nevada, New Mexico, and Texas.
[4] Total withheld data included with "Total quanity" for each respective district or State.
[5] Mostly cinder and sinter obtained from treating pyrites. Ore was treated in Delaware, New Mexico, Pennsylvania, Tennessee, and Virginia.

Table 9.—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	1971 Direct shipping ore	1971 Agglomerates	1971 Concentrates	1971 Iron content (natural percent)	1972 Direct shipping ore	1972 Agglomerates	1972 Concentrates	1972 Iron content (natural percent)
Lake Superior:								
Michigan	732	10,560	627	62	}4,088 (Michigan and Minnesota)	10,717	}11,311 (Michigan and Minnesota)	63
Minnesota	3,335	33,771	14,178	60		34,546		60
Wisconsin	--	832	--	64	--	888	--	65
Total reportable	4,067	45,162	14,805	61	4,088	46,151	11,311	61
Southeastern States:								
Alabama	--	--	351	47	--	--	311	47
Georgia and North Carolina	--	--	176	48	--	--	122	50
Total reportable	--	--	527	47	--	--	433	48
Northeastern States: New York and Pennsylvania	--	W	W	63	--	W	W	64
Western States:								
Arizona	16	--	--	e 58	(1)	--	--	56
Missouri	--	2,625	17	65	--	2,661	23	65

See footnotes at end of table.

Table 9.—Usable iron ore produced in the United States, by district, State and type of product—Continued

(Thousand long tons and exclusive of ore containing 5% or more manganese)

District and State	1971				1972			
	Direct shipping ore	Agglomerates	Concentrates	Iron content (natural percent)	Direct shipping ore	Agglomerates	Concentrates	Iron content (natural percent)
Western States—Continued								
Montana	14	--	--	[e] 45	9	--	--	45
Utah	W	--	W	53	W	--	W	55
Wyoming	W	W	W	59	W	W	W	60
Other [2]	383	W	W	59	408	W	W	60
Total reportable	413	2,625	17	60	417	2,661	23	61
Total withheld	1,278	6,723	4,430	60	1,326	5,808	2,907	60
Total all States [3]	5,757	54,511	19,779	60	5,830	54,620	14,674	61
Byproduct ore [4]	--	603	112	64	--	227	83	63
Grand total [3]	5,757	55,114	19,891	60	5,830	54,847	14,757	61

[e] Estimate. W Withheld to avoid disclosing individual company confidential data; included with "Total withheld."
[1] Included with "Other."
[2] Includes Arizona (1972), California, Colorado, Idaho, Nevada, New Mexico, and Texas.
[3] Data may not add to totals shown because of independent rounding.
[4] Mostly cinder and sinter obtained from treating pyrites.

Table 10.—Shipments of usable iron ore from mines in the United States in 1972

(Thousand long tons and thousand dollars; exclusive of ore containing 5% or more manganese)

District and State	Gross weight of ore shipped				Iron content of ore shipped				Total value [1]
	Direct shipping ore	Agglomerates	Concentrates	Total quantity [1]	Direct shipping ore	Agglomerates	Concentrates	Total quantity [1]	
Lake Superior:									
Michigan } Minnesota }	4,271	11,672	11,978	12,692	2,148	7,340	6,565	7,865	177,461
Minnesota		35,366		50,595		22,169		30,356	601,869
Wisconsin	--	887	--	887	--	578	--	578	W
Total reportable	4,271	47,925	11,978	64,174	2,148	30,087	6,565	38,799	779,330
Southeastern States:									
Alabama	--	--	327	327	--	--	151	151	1,912
Georgia and North Carolina	--	--	122	122	--	--	60	60	863
Total reportable	--	--	449	449	--	--	211	211	2,775
Northeastern States: New York and Pennsylvania	--	W	W	2,346	--	W	W	1,514	38,480
Western States:									
Missouri	--	2,673	23	2,695	--	1,743	16	1,759	W
Montana	9	--	--	9	4	--	--	4	W
Utah	1,304	--	483	1,788	721	--	269	990	W
Wyoming	6	W	W	2,030	2	W	W	1,227	W
Other [2]	283	W	W	4,393	178	W	W	2,596	38,710
Total reportable	1,602	2,673	506	10,915	905	1,743	285	6,576	50,845
Total withheld	--	5,971	2,509	([3])	--	3,742	1,415	([3])	91,070
Total all States	5,873	56,569	15,442	77,884	3,053	35,571	8,476	47,100	950,365
Byproduct ore [4]	--	402	--	402	--	264	--	264	4,161
Grand total [1]	5,873	56,972	15,442	78,287	3,053	35,835	8,476	47,365	954,527

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 (1972), California, Colorado, Idaho, Nevada, New Mexico, and Texas.
[3] Total withheld data included with "Total quantity" for each respective district or State.
[4] Mostly cinder and sinter obtained from treating pyrites. Ore treated in Delaware, New Mexico, Pennsylvania, Tennessee, and Virginia.

Table 11.—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]
1954–1967	359,601	296,591	320,334	103,528	2,613,767	69,375	8,066	--	3,771,261
1968	10,086	3,684	--	--	51,411	961	83	--	66,224
1969	10,048	3,369	--	--	55,275	--	--	38	68,730
1970	10,363	2,394	--	--	56,073	--	--	806	69,636
1971	9,495	2,424	--	--	51,283	--	--	832	64,034
1972	9,131	2,533	--	--	48,998	--	--	888	61,550
Total	408,724	310,995	320,334	103,528	2,876,807	70,336	8,149	2,564	4,101,435

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

Table 12.—Average analyses of total tonnage[1] of all grades of iron ore shipped from the U.S. Lake Superior district

Year	Thousand long tons	Content percent[2]					
		Iron	Phosphorus	Silica	Manganese	Alumina	Moisture
1968	64,065	58.70	0.051	7.35	0.40	r 0.80	5.16
1969	71,389	r 59.04	.045	7.32	.45	.69	4.82
1970	69,072	r 59.36	.041	r 7.40	.39	.72	r 4.62
1971	61,776	r 60.06	r .039	r 7.08	r .33	r .59	r 4.69
1972	64,721	60.40	.031	6.76	.30	.52	3.93

r Revised.
[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, 1972, p. 90.

Table 13.—Consumption of iron ore and agglomerates in the United States in 1972

(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	3,079	W	7,329	W	NA	10,408
California, Colorado, Utah	1,439	W	5,608	W	NA	7,047
Ohio and West Virginia	4,997	W	21,958	W	NA	26,955
Illinois and Indiana	2,394	W	29,347	W	NA	31,741
Michigan and Minnesota	109	W	9,131	W	NA	9,240
Maryland, New York, Pennsylvania	9,176	W	30,298	W	NA	39,474
Undistributed	--	946	--	529	e 603	2,078
Total	21,194	946	103,671	529	e 603	126,943

NA Not available. W Withheld to avoid disclosing individual company confidential data.
[1] Not including pellets or other agglomerated products.
[2] Includes 58,074,000 tons of pellets produced at U.S. mines, and 9,833,000 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.

Table 14.—Iron ore consumed in production of agglomerates at iron and steel plants in 1972, by State

(Thousand long tons)

State	Iron ore consumed [1]	Agglomerates produced
Alabama, Kentucky, Texas	6,060	3,440
California, Colorado, Utah	969	2,209
Ohio and West Virginia	3,016	4,557
Illinois, Indiana, Michigan	6,753	9,614
Maryland, New York, Pennsylvania	13,252	15,561
Total	30,050	35,381

[1] Including domestic and foreign ores.

Table 15.—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	Total	Proportion of beneficiated to total (percent)
1968	72,781	81,934	88.8
1969	80,157	89,854	89.2
1970	79,779	87,176	91.5
1971	70,456	77,106	91.4
1972	72,011	77,883	92.5

[1] Beneficiated by further treatment than ordinary crushing and screening. Excludes byproduct ore.

Table 16.—Production of iron ore agglomerates [1] in the United States, by type

(Thousand long tons)

Type	Agglomerate produced	
	1971	1972
Sinter, nodules, and cinder	[2] 35,775	[3] 36,702
Pellets	53,055	53,528
Total	88,830	90,230

[1] Production at mines and consuming plants.
[2] Includes 17,664 thousand tons of self-fluxing sinter.
[3] Includes 18,819 thousand tons of self-fluxing sinter.

Table 17.—Stocks of usable iron ore at mines [1] Dec. 31, by district

(Thousand long tons)

District	1971	1972
Lake Superior	10,711	8,031
Southeastern States	778	665
Northeastern States	4,968	5,215
Western States	1,196	768
Total	17,653	14,679

[1] Excluding byproduct ore.

Table 18.—Average value of usable iron ore [1] shipped from mines or beneficiating plants in the United States in 1972

(Dollars per long tons)

Type of ore	District			
	Lake Superior	Southeastern	Northeastern	Western
Direct-shipping, hematite and magnetite	6.36	--	--	6.64
Concentrates, hematite and magnetite	7.43	W	W	6.86
Concentrates, limonite	--	6.09	--	W
Agglomerates	14.12	--	16.72	13.14

W Withheld to avoid disclosing individual company confidential data.
[1] F.o.b. mine or plant. Excludes byproduct ore.

Table 19.—U.S. exports of iron ore, by country

(Thousand long tons and thousand dollars)

Country	1970		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value
Belgium-Luxembourg	127	1,756	(1)	15	--	--
Canada	2,045	27,111	1,245	17,180	1,442	20,067
Germany, West	34	96	19	53	44	122
Japan	3,206	37,727	1,794	20,850	608	6,553
Spain	75	1,095	--	--	--	--
Other	5	113	3	49	1	34
Total	5,492	67,898	3,061	38,147	2,095	26,776

[1] Less than ½ unit.

Table 20.—U.S. imports for consumption of iron ore, by country

(Thousand long tons and thousand dollars)

Country	1970		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value
Australia	638	7,389	1,008	12,692	687	9,245
Brazil	1,991	17,865	1,772	16,547	1,115	11,990
Canada	23,934	297,203	20,342	267,424	18,168	247,757
Chile	1,581	12,805	878	7,152	308	2,877
Liberia	1,873	17,216	1,838	16,768	2,761	22,740
Libya	103	789	--	--	--	--
Mauritania	72	664	--	--	40	687
Nigeria	30	152	52	399	85	729
Norway	49	356	--	--	(1)	6
Peru	1,329	13,771	1,063	12,443	1,318	15,048
Sweden	172	1,909	178	2,220	273	3,952
Uruguay	49	444	--	--	--	--
Venezuela	13,026	108,493	12,953	114,176	10,926	99,951
Other	44	462	40	843	80	952
Total	44,891	479,518	40,124	450,644	35,761	415,934

[1] Less than ½ unit.

Table 21.—U.S. imports for consumption of iron ore, by customs district

(Thousand long tons and thousand dollars)

Customs district	1971		1972	
	Quantity	Value	Quantity	Value
Baltimore, Md	8,452	91,103	7,515	75,346
Buffalo, N.Y	2,507	38,122	2,085	33,665
Chicago, Ill	4,596	57,961	5,505	73,300
Cleveland, Ohio	6,026	72,880	5,153	67,272
Detroit, Mich	859	13,851	954	13,539
Houston, Tex	258	3,690	478	7,285
Los Angeles, Calif	101	812	37	292
Mobile, Ala	4,762	46,717	3,489	34,416
New Orleans, La	500	4,944	838	9,269
Ogdensburg, N.Y	3	337	4	444
Philadelphia, Pa	11,718	115,999	9,157	94,189
Portland, Oreg	114	1,332	288	3,094
Wilmington, N.C	223	2,516	257	3,819
Other	5	380	1	4
Total	40,124	450,644	35,761	415,934

Table 22.—Iron ore, iron ore concentrates and iron ore agglomerates: [1] World production by country

(Thousand long tons)

Country [2]	1970	1971	1971 p
North America:			
Canada [3]	46,709	43,281	39,531
Mexico [4]	4,285	4,624	5,009
Panama	--	--	76
United States [5]	89,760	80,762	75,434
South America:			
Argentina	r 236	278	227
Bolivia (exports)	4	6	e 51
Brazil e	39,600	42,000	41,400
Chile	11,087	11,048	8,495
Colombia	446	435	409
Peru	9,559	8,691	9,266
Uruguay	1	3	1
Venezuela	21,751	20,000	18,173
Europe:			
Albania e [6]	531	558	585
Austria	3,934	4,105	4,067
Belgium	92	92	111
Bulgaria	2,371	2,954	3,189
Czechoslovakia	r 1,581	1,584	1,594
Denmark	26	15	15
Finland [7]	r 982	864	979
France	55,908	54,980	53,396
Germany, East [8]	415	313	e 250

See footnotes at end of table.

Table 22.—Iron ore, concentrates and iron ore agglomerates:[1] World production by country—Continued

(Thousand long tons)

Country [2]	1970	1971	1972 p
Europe—Continued			
Germany, West	5,444	4,941	4,748
Hungary	619	676	684
Italy [9]	745	672	606
Luxembourg	5,632	4,436	4,051
Norway	r 3,945	3,992	3,860
Poland	2,513	2,045	1,630
Portugal [10]	124	97	43
Romania	r 3,155	3,412	e 3,400
Spain	r 6,940	7,213	6,605
Sweden	r 31,011	33,824	32,601
U.S.S.R.	r 192,404	199,802	204,715
United Kingdom	11,828	10,067	8,906
Yugoslavia	3,636	3,666	3,897
Africa:			
Algeria	2,818	3,098	3,605
Angola	5,956	6,061	e 4,800
Egypt, Arab Republic of	444	465	e 465
Liberia	r 23,287	24,245	24,206
Mauritania	8,959	8,323	e 9,300
Morocco	859	613	230
Rhodesia, Southern e	500	500	500
Sierra Leone	2,259	2,507	2,284
South Africa, Republic of [11]	7,605	10,509	11,146
Swaziland	2,512	2,841	1,952
Tunisia	762	921	876
Asia:			
China, People's Republic of e	43,000	r 44,000	45,000
Hong Kong	168	160	160
India	30,871	33,720	34,483
Indonesia	--	267	262
Iran [12]	10	150	e 300
Japan [13]	1,550	1,398	1,325
Korea, North e	7,900	8,400	8,600
Korea, Republic of	562	496	484
Malaysia	4,420	935	520
Philippines	1,840	2,208	2,170
Taiwan	6	--	28
Thailand	22	39	27
Turkey	r 2,903	2,047	1,928
Oceania:			
Australia	50,380	61,119	62,812
New Zealand [14]	146	567	1,359
Total	r 757,013	767,025	756,826

e Estimate. p Preliminary. r Revised.

[1] Insofar as availability of sources permit, 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.

[2] In addition to the countries listed, Cuba and North Vietnam may produce iron ore but definitive information on output, if any, is not available.

[3] Shipments, dry tons, including byproduct ore.

[4] Calculated from reported iron content assuming a grade of 60% iron.

[5] Includes byproduct ore.

[6] Nickeliferous iron ore.

[7] Includes magnetite concentrate, pelletized iron oxide (from pyrite sinter) and roasted pyrite (purple ore).

[8] Includes pyrite sinter, not separable from available sources.

[9] Excludes iron oxide pellets produced from pyrite sinter.

[10] Includes manganiferous iron ore as follows, in thousand long tons: 1970—53, 1971—47, 1972—41.

[11] Includes byproduct magnetite as follows in thousand long tons: 1970—1,936, 1971—2,193, 1972—2,952; and manganiferous iron ore (20% to 35% iron, 15% to 30% manganese) as follows in thousand long tons: 1970—368, 1971—179, 1972—100.

[12] Year beginning March 21 of that stated.

[13] Concentrates including concentrate derived from iron sand as follows in thousand long tons: 1970—701, 1971—581, 1972—539.

[14] Largely concentrates from magnetite-titanium sands.

Iron and Steel

By F. E. Brantley [1]

The iron and steel industry continued to recover during the first part of the year from its poor performance in 1971. Except for a brief midseason slump, this momentum was maintained for the remainder of the year and total raw steel [2] production was up 10.6% over that of 1971. Steel mill shipments increased almost 5 million tons, but were 2 million tons short of the record set in 1969. Returns on sales and investment again were among the lowest for any industry, and it was apparent that a number of problems needed to be resolved if this segment of the Nation's economy is to maintain a position of world leadership. The most pressing were as follows: Shortage of available capital for installation of more efficient steelmaking equipment and for expansion, limiting the increasing imports, rebuilding of export markets, pollution controls, rising costs of raw materials (particularly ferrous scrap), and the threat of energy shortages.

Extensions of voluntary steel import restraints were agreed to by Japan and the European Community (EC) countries. However, a number of other countries markedly increased shipments into the United States. Apparent consumption of steel products, adjusted for imports and exports, was up 4%.

Increased steel production was reported for all major producing countries of the world, and accompanied a general improvement in the world's economic situation. Total world raw steel production increased by 8 percent to 692 million short tons, and the U.S.S.R. increased its lead as the world's largest producer at 139 million tons. Japan was in third place, after the United States, with 107 million tons. Spain's production reached 10 million tons, a 23% increase over 1971 output.

[1] Physical scientist, Division of Ferrous Metals, Assistant Directorate—Mineral Supply.

[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.

Table 1.—Salient iron and steel statistics

(Thousand short tons)

	1968	1969	1970	1971	1972
United States:					
Pig iron:					
Production	88,767	95,003	91,293	81,382	88,864
Shipments	89,085	95,472	91,272	81,332	89,048
Exports	9	44	310	34	15
Imports for consumption	786	405	249	306	637
Steel: [1]					
Production of raw steel:					
Carbon	116,269	124,832	117,411	107,007	117,698
Stainless	1,432	1,569	1,279	1,263	1,564
All other alloy	13,761	14,861	12,824	12,173	13,979
Total	131,462	141,262	131,514	120,443	133,241
Index [2]	103.1	111.0	103.4	94.7	104.5
Total shipments of steel mill products	91,856	93,877	90,798	87,038	91,805
Exports of major iron and steel products	2,673	5,788	7,657	3,526	3,546
Imports of major iron and steel products [3]	18,346	14,528	13,861	18,744	18,158
World production:					
Pig iron	418,000	453,000	475,000	474,000	499,000
Raw steel (ingots and castings)	584,000	633,000	655,000	640,000	692,000

[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] Data not comparable for all years.

Price advances to keep pace with inflationary trends occurred for steel products in most sectors of the world market. In the free world, trends toward consolidation of plants, and company mergers to reduce costs were the effects of economic and technological developments. Continued increases in small electric-arc furnace steelplants were occurring also in many areas where limited production was desired.

U.S. merchant iron producers were reduced to five during the year, and ferrous foundries to approximately 1,900. The cost of pollution control equipment placed in operation by U.S. steelmakers during the year totaled $201.8 million, with an additional $336 million budgeted for 1973 and later. Total capital outlay for new facilities was $1.2 billion.

PRODUCTION AND SHIPMENTS OF PIG IRON

Domestic production of pig iron totaled 88.9 million tons in 1972, an increase of 7.5 million tons, or 9.2% more than that produced in 1971. Average production of pig iron per blast-furnace-day increased to 1,789.6 tons, compared with 1,654.3 tons in 1971, and 1,641.6 tons in 1970, according to the American Iron and Steel Institute (AISI). A total of 126 blast furnaces were in blast at the beginning of the year, including three that produced ferroalloys. At yearend the total number in blast had increased to 143, with two producing ferroalloys. There were 216 producing furnaces at the beginning of the year, and 214 at yearend, of which ten were being relined and one rebuilt.

Shipments of pig iron approximated total production for 1972. Yearend stocks at consumer and supplier plants were down 119,000 tons, 6.7% under those of 1971.

Metalliferous Materials Consumed in Blast Furnaces.—For each ton of pig iron produced in 1972, an average of 1.634 tons of metalliferous materials was consumed in the blast furnaces. Total net iron ore consumed in blast furnaces including agglomerates, was 137.9 million short tons. The total tonnage of iron ore including manganiferous ore, consumed by agglomerating plants at or near the blast furnaces in producing 39.6 million tons of agglomerates was 34.0 million tons. The remainder consisted of mill scale, coke, limestone, dolomite, and small amounts of other materials. Domestic pellets charged to the blast furnaces totaled 64.7 million tons, and sinter charged was 40.5 million tons. Pellets and other agglomerates from foreign sources added an additional 10.8 million tons.

Blast furnace oxygen consumption totaled 15.5 billion cubic feet according to the AISI, compared with 13.3 billion in 1971, and 13.5 billion cubic feet in 1970.

Data reported to the Bureau of Mines by the iron and steel industry showed that blast furnaces, through tuyere injection, consumed 22.8 billion cubic feet of natural gas, 4.3 billion cubic feet of coke oven gas, 183.1 million gallons of oil, and 67.5 milion gallons of tar, pitch, and miscellaneous fuel in 1972.

PRODUCTION AND SHIPMENTS OF STEEL

Domestic raw steel production edged slowly upward during the first half of the year, and although the 66.1 million tons produced in the first six months was below that for the same period in 1971, an increase during the last few months raised the year's total to 133.2 million tons. This was 12.8 million tons above the 1971 output, or an 8% increase.

The 1972 steel index, based on production in 1967 as 100, was 104.5, compared with 94.7 for 1971, and 103.4 for 1970. Of the total 1972 output, 56.0% was produced by the basic oxygen process (BOP), 26.2% by open-hearth furnaces, and 17.8% by electric furnaces.

Shipments of steel products for the year were up 5.5%, from 87.0 million tons in 1971 to 91.8 million tons in 1972. At yearend all signs pointed to a continuation of the sharp rate of increase evident during the last few months of the year. The largest markets were steel service centers and the automotive industry. Each accounted for over 18 million tons. Percentagewise, shipments by types of steel were approximately the same in 1972 as for 1971.

Materials Used in Steelmaking.—Metallics charged to domestic steel furnaces in 1972 per ton of steel produced averaged 1,246 pounds of pig iron, 1,103 pounds of scrap and 25 pounds of iron ore including agglomerates. In 1971 comparable amounts were 1,269 pounds of pig iron, 1,051 pounds of scrap, and 35 pounds of iron ore.

According to AISI, steelmaking furnaces consumed 531,100 tons of fluorspar, 2.2 million tons of limestone, 6.6 million tons of lime, and 1.1 million tons of other fluxes. Oxygen consumption by the iron and steel industry in steelmaking amounted to the equivalent of 189.5 billion cubic feet compared with 166.7 billion in 1971.

CONSUMPTION OF PIG IRON

Pig iron consumed in steelmaking totaled 83.57 million tons. Basic oxygen converters consumed 60.23 million tons; open hearths, 22.38 million tons; and electric furnaces, 0.96 million tons. An additional 2.66 million tons was consumed by iron foundries and miscellaneous users, primarily for charging cupola furnaces. Also, 2.9 million tons in the form of molten metal was used in making ingot molds and direct castings.

PRICES

Price increases previously announced by several companies for a variety of steel products, under authorization of the Federal Price Commission, went into effect January 1. Pricing during January was difficult to follow as various discounts and concessions were introduced by several companies in a short-lived price war. The finished steel composite price published by Iron Age decreased for February and remained stable for the rest of the year. Announcements were made by some companies that prices, in general, would be frozen for the rest of the year.

A widespread practice of distributor discounting on stainless sheet and coil caused a drop in composite prices of these items in June. This was followed in July by a stainless steel plate price increase of 5% by a few producers. Base price cuts of 20% for stainless plate had been previously announced by some mills in March. General tool steel raises were put into effect during the year. An increase of $3.35 per short ton for merchant pig iron also was posted by major producers during the year.

The composite price of pig iron, according to Iron Age, increased from $70.18 per short ton for January to $72.53 for December, and the composite price of finished steel went from $180.28 per ton for January to $179.76 for December. Comparable January and December prices, at Pittsburgh, for hot-rolled sheets were $172 and $167 per ton, and for cold-rolled sheets $185 and $202 per ton.

Price increases occurred in most major free world steel-producing countries during the year or were announced for 1973. West German producers applied in midyear to the European Communities Commission for increases averaging 4%, and Japanese steel export prices were reported to have risen by 15 to 20% during the year.

FOREIGN TRADE

The Voluntary Restraint Arrangement (VRA) limiting steel exports to the United States was regarded as basically successful for 1972. Participating countries—Japan, the United Kingdom, and the European Community—would limit for the 3-year period 1972–74, under terms expressed in letters of intent to the Secretary of State, the quantity of steel mill products exported to the United States. Both product mix and geographical mix was considered in limiting the shipments for each year. The 5% annual growth in the 1969–71 VRA was reduced to 2.5%, more in line with the historic pattern of the U.S. steel market increase. Japan also agreed to limit U.S. West Coast shipments to not more than one-third of total shipments. The terms were adhered to with few exceptions. There were differences in product classifications used by each country, also variations because of lag in times between export and import dates. The Japanese Minister of International Trade and Industry approved cartel arrangements for that country's steelmakers covering exports of various steel products to the United States for the year.

During the year, the legality of the VRA was challenged by the Consumers Union in a suit filed in the U.S. District Court for the District of Columbia. Prior to this suit, Japan had offered to reduce their 1973 exports to the U.S. West Coast to bring total shipments by both VRA participants and nonparticipants within the one-third limitation. Also during 1972, the Department of State had discussions relative to steel exports with several nonparticipating countries. These countries had increased shipments to the United States with resulting complaints by domestic producers, and efforts to obtain legislative relief.

Data compiled by AISI showed that imports of total steel products amounted to 18.3 million tons compared with 18.9 million in 1971. Steelmill product imports declined from the 1971 total of 18.3 million tons to 17.7 million tons. VRA participants accounted for 80% of the U.S. steel imports, compared with 84.3% in 1971, and total imports accounted for 16% of the domestic steel market, compared with 18% in 1971.

Exports of total steel products were essentially unchanged, 3.20 million tons for 1972 compared with 3.16 million tons in 1971. The chairman of AISI called for increased efforts to stimulate exports of steel from the United States to obtain a share of the increasing worldwide steel consumption.

WORLD REVIEW

Australia.—A preliminary proposal was submitted to the Commonwealth Government by the Government of Western Australia for an industrial complex in the Pilbara region. Costing $6.82 billion, the proposal included a steelworks with a capacity of 10 million tons per year. Major industries were expected to invest approximately 40% of the total amount, but at least one-half of the private industry development was to be home owned.

The 4-year expansion program at the Port Kembla steelworks of Australian Iron and Steel Proprietary Ltd. (Broken Hill subsidiary) continued. Completed in the third year of the program was a new blast furnace, and a steelmaking shop with two 225-ton oxygen converters. An article describing all phases of the new plant was published.[3]

An expansion program at the John Lysaght (Australia) Ltd. Westernport plant includes new mills and finishing facilities. Temporarily set back by labor difficulties, all units were expected to be in operation by 1974.

Canada.—Canada's steel industry had a record production year, with an increase of approximately 7% over the previous high in 1970. All major steel companies recorded increases, except Sydney Steel Corp. A labor strike there which lasted a month, also delayed the company's modernization program.

The Algoma Steel Corp. Ltd. was on schedule with its major construction jobs which included a new basic oxygen shop and a new blast furnace.

The Steel Co. of Canada Ltd. (STELCO) started the first phase of a $19 million expansion program at its Edmonton steelworks. Major new items would be two 75-ton electric arc furnaces and a continuous casting unit. STELCO also started a new $14.5 million electric furnace steelmaking plant at its McMaster works in Contrecoeur, to become operational by 1974. At the company's Hilton works in Hamilton three basic oxygen converters, a new bloom and billet mill, and a coke oven battery were brought on stream. These represented a total cost exceeding $160 million. STELCO also restarted its engineering studies on a new steel complex at Nanticocke, Ontario, on Lake Erie.

Dominion Foundries and Steel, Ltd. (DOFASCO) started up a new electrolytic tinning line and continued construction of equipment to control pollution problems.

[3] Pitt, R. S. Steelmaking at Port Kembla. Iron and Steel, v. 45, No. 5, October 1972, pp. 527–540.

Sidbec-Dosco Ltd., the New Government-owned integrated steel company, started its electric furnace steelplant at Contrecoeur and operated on scrap in 1972. The metallized pellet facility was expected to supply feed for the furnaces in 1973. Steel capacity of 600,000 tons per year was given.

Cominco Ltd. ceased operating its electric furnace pig iron and basic oxygen steelmaking facilities at Kimberley, British Columbia, since they were no longer considered to be economic.

Capital expenditures by the iron and steel industry, including foundries, in Canada were estimated at $431 million, compared with $427 million in 1971.

China, People's Republic of.—As part of China's expanding trade relations with the Western World, steel was one of the priority commodities in 1972. Chinese steel missions were active and several contracts were negotiated for the purchase of finished products. Contracts with Japanese steelmakers called for about 1.5 million tons to be delivered during the first half of 1973. Purchases were reported also from Australia and West Germany.

Interest in purchasing technology for the iron and steel industry as well as complete facilities was evident in reports from Japan. An official request for a firm bid was made of a Japanese firm and involved an estimated $300 million for hot and cold strip mills, a tinning line, a galvanizing line, and other mill equipment.

Steel production is expected to continue at a rate of increase approaching 10% per year. Demand was forecast as high as 42 million tons in 1975 according to Japanese studies. Present steelmaking capacity is indicated at 23 million tons, which includes 14 major works each having a capacity of over 1 million tons.

France.—There were four major steel projects in which activity was concentrated and which could be expected to influence the future steel position of France. These were:

1. The expansion at Dunkirk which would double the capacity of the Usinor steelworks. Included in the plans were a 10,000-ton-per-day blast furnace and a new oxygen steel plant. Production of raw steel would approach 9 million tons per year by 1975.

2. A new oxygen steel plant to be constructed as part of the Gandrange works at Orne-Aual by Sacilor, a subsidiary of the Wendel-Sidélor group. This with other construction, would be one of the centers around which the Lorraine steel industry would be based. Involved would be the closing of outdated plants and the regrouping of production in modern facilities.

3. Completion of the integrated steel complex at Fos. Usinor joined the Wendel-Sidélor group as a participant and a third partner was expected to share in the $1 billion undertaking. The first pig iron has been scheduled to be produced here early in 1974, with some rolling to take place in late 1973.

4. The expansion in specialty steel capacity was highlighted by plans for a new electric furnace works at Isbergues as a joint venture of Creusot-Loire and Châtillon-Commentry-Biache, and the Péchiney Ugine-Kuhlmann installation near Fos.

Under the sixth plan, the production targets set for 1975 would give France a maximum steel capacity by that date of approximately 35 million tons. This figure was based on an expected average annual rate of increase of 5% in the domestic steel market, and the deficit steel trade balances of recent years.

The Nation's steel companies numbered about 60 in 1972, with the top five producers accounting for three-fourths of total steel produced. Continued regroupings have occurred since 1947 when the steel industry numbered 122 companies. In recent years mergers, establishment of joint subsidiaries, and agreements between companies have been resorted to, in order to keep the French steel industry competitive. Increased expenditures scheduled for iron and steel research also are expected to be a factor in strengthening the industry.

Germany, Federal Republic of.—West German steelmakers slowly started to regain the position held prior to the slump which culminated in 1971, and resulted in 1971 being called one of the worst years on record. Raw steel production in 1972, 48.2 million tons, was still 1.5 million tons below that of 1970.

Capital investments continued high but were below the total for the previous year. With steel price increases lagging production cost increases, it was the general opinion that favorable profitability would not occur before 1973. The Thyssen Steel group, August Thyssen Hütte A. G. (ATH), Europe's largest steel producer, scheduled $217 million for capital spending in 1972 compared with $317 million the previous year. ATH's new blast furnace at Duisburg-Huckingen was completed. The group also set up a new company, Thyssen Purofer G.m.b.H., to further large-scale applications of its Purofer direct-reduction process. Thyssen Niederrhein, another new company of ATH, was to combine part of the group's special steel operations, including takeover of part of the operations formerly handled by ATH and Mannesmannröhren-Werke.

The new steel mill, Hamburger Stahlwerke G.m.b.H. (HSW), of the Korf group was officially inauguarated in April. The installation, built at a cost of $75.8 million, uses the Midland-Ross direct-reduction process, and has a capacity of approximately 600,000 tons per year. Klöeckner-Werke A. G. of West Germany planned to take a minority interest in HSW and receive the excess of continuously cast billets for its plant. It was estimated that HSW would increase raw steel production to 800,000 tons per year after the deal is concluded.

Th. Wuppermann G.m.b.H. was to install a new electric melting shop at Leverkusen with a capacity of approximately 500,000 tons per year. Scrap would be used initially as the charge material with partial use of prereduced pellets later.

Hoesch A. G. and Hoogovens of the Netherlands created a joint holding company, ESTEL N.V. (Hoesch-Hoogovens) in July at Arnhem. Raw steel capacity of the combine would be 12 million tons per year, third in Western Europe behind the British Steel Corp. and ATH.

Fried. Krupp Hüttenwerke A. G. became the first German producer of stainless steel using the argon-oxygen decarburization (AOD) method. The equipment was placed in operation at the firm's Bochum plant in August as part of its modernization program.

India.—Takeover of the Indian Iron and Steel Co. (IISCO) by the Government was approved by both Houses of Parliament for a period of 2 years. IISCO was the second largest steel producer in the private sector, but was reported to be in financial trouble and also not able to maintain production. A new Government holding company for steel, the Steel Authority of India Ltd. (SAIL), was established as part of an effort to reshape and revitalize the steel industry. SAIL will have jurisdiction over all phases of the steel industry and formulate long-term programs to involve industries such as coking coal, iron ore, and others necessary for steel production. India's steel industry has not been able to fully utilize existing plant capacity and, with high foreign exchange costs of imported steel, a critical supply shortage has persisted.

Capacity of the Bhilai steel plant was to increase from 2.75 to 4.4 million tons, according to an agreement signed in Moscow in July by representatives of India and the Soviet Union. Date of implementation of the project was not specified.

An announcement was made by the Government in September that it would establish a public sector company for construction and operation of a 275,000-ton capacity steel plant at Salem, Tamil Nadu. The company, to be known as the Salem Steel Co., would have an authorized investment of $133.3 million. Similar separate companies were expected to be set up for steel plants at Visakhapatnam and Vijayanagar.

Licenses for electric furnace-continuous casting steel plants, having a total capacity of 1 million tons per year, have been issued by the Government since the minimill program became a high-priority item. The plants would be located in 10 states.

Japan.—Recovery from the general world steel recession of 1971 was evident in Japan during 1972, as raw steel production reached a record high of 106.8 million tons. This was 4 million tons above the previous high annual production of 1970, and 9% over the 1971. The Japan Iron and Steel Federation listed the country's total raw steel capacity at approximately 137 million tons, and pig iron capacity at 105 million tons. The Ministry of International Trade and Industry (MITI) estimated raw steel capacity to reach 159 million tons in 1975. All pig iron capacity was by blast furnaces except 500,000 tons that represented output of electric and other furnaces. The 67 blast furnaces have an average daily capacity of 4,198 tons.

Of the 1972 total, steel produced by the basic oxygen process comprised 79.4%; by electric furnaces, 18.6%; and open hearths, 2.0%. In December, the Fukuyama Works of Nippon Kokan K. K. poured 111,660 tons of raw steel, which was reported as a record for one plant. The plant's No. 4 blast furnace had an average daily output of 11,150 tons for the month.

Nippon Steel Corp.'s eighth integrated steel plant, the Oita Works, started production in 1972. The plant started up two 300-ton basic oxygen converters with an annual capacity of 3.85 million tons which would supply continuous slab casters. Approximately 25% of Japan's raw steel production is made by continuously cast methods.

Pollution control was becoming a major concern of the Japanese iron and steel industry. In Japanese fiscal year 1972 approximately $265 million was scheduled for investment by the industry for control equipment. Of this, 63% would be for air pollution control, 23% for water pollution control, and the remainder for noise, industrial waste, and other controls. One company planned for a long-range offshore construction program to lessen contamination of populated areas by its steelworks.

Capital improvements were continued by all major producers, although at a reduced pace. Some blast furnace construction postponed because of the 1971 decline was started again and at least two large furnaces were placed in operation: Nippon Steel's Oita No. 1, which was in the 11,000-ton class, and its Tobata No. 4, initially scheduled at 8,800 tons per day, and to be expanded later to 11,000 tons.

Cartels approved by the Fair Trade Commission for eight major steel producers and six stainless steel companies were extended through December. The extension was made in June because of the supply-demand gap in various steels and the fear that the operators would suffer if the cartels were dissolved.

One result of Japan's large buildup of foreign exchange reserves has been to expand steel project financing and construction in other world areas. In 1972 Japanese assistance in construction of a second blast furnace and expansion of the Pohang steelworks in South Korea was planned. Japanese interests purchased land at Auburn, N.Y., and prepared to erect a steel mini-mill, which would be completed in 1974. Nippon Steel Corp., Mitsubishi Corp., and Mitsui & Co. signed agreements to invest in the Mexican steel firm Cía. Fundidora de Fierro y Acero de Monterrey S.A. (Fundidora), which was to expand production. Contracts were signed also by Nippon Steel for construction of two large blast furnaces in Brazil to be completed in 1974–75.

The technological, social, economic, and other factors affecting the Japanese steel industry were discussed by the executive director of Japan's Iron and Steel Institute.[4]

Korea, Republic of.—South Korea had underway an industrial expansion program oriented mainly around development of iron and steelmaking facilities. Under plans outlined by the Ministry of Commerce and Industry, shipbuilding would become the leading export industry, with an expected volume of $2 billion in 1980, compared with $15 million in 1972.

The country's first stainless steelworks began operation and reached designed capacity during the year. This operation, Samyang Special Steel at Ulsan, was in the first Asian country to produce stainless sheet, outside of Japan, using the Sendzimir mill. To help the new industry, the Government placed a ban on imports of sheet products similar to those produced by the plant. The Nation also had under construction its first integrated steelworks, the nationalized Pohang Iron and Steel Co. (POSCO). Capacity would exceed 1 million tons of steel annually in 1973, when the first blast furnace was to start up. Planned expansion called for a steel capacity of 2.9 million tons with a tentative completion date of 1978. The final goal would be 5.5 million tons of raw steel, and the operation has been planned accordingly for the future.

Luxembourg.—The two steel companies operating in Luxembourg accounted for approximately one-half of the Nation's industrial production and payroll, and 70% of its industrial exports. Aciéries Réunies de Burbach-Eich-Dudelange S.A. (ARBED) accounted for about 90% of the steel production and S.A. Minière et Métallurgique de Rodange (MMR) the remainder. ARBED completed a 5-year $250 million modernization program in 1972 designed

[4] Tabata, S. Problems and Actual Situation of the Japanese Iron and Steel Industry. Iron and Steel, v. 45, No. 3, June 1972, pp. 299–302.

mainly to increase productivity. Included in this program was replacement of small blast furnaces with larger and more efficient units, and the production of specific mill products at certain locations in order to minimize duplication. MMR was scheduled for improvements after a proposed merger. Luxembourg had a per capita steel production of 16 tons per person, the highest in the world. However, it exports approximately 95% of its output.

Mexico.—Mexico's largest industrial venture, the Las Truchas steel complex, moved toward the construction stage with the completion of major planning details during 1972. The British Steel Corp. in competitive bidding, was awarded the position of project advisor. Suppliers for mill and ancillary equipment, estimated to have a value of $300 million, were registered and bids on the major items were expected to be awarded in 1973. The operating firm will be known as Siderúrgica Lázaro Cardenas-Las Truchas, S.A. (SICARTSA) and will have as its major stockholder the Government of Mexico. Overall cost of the first phase of the operation would be $500 million, with physical construction to begin the second half of 1973 and be completed in 1976. Production capacity for finished and semifinished steel would be approximately 1.4 million tons per year. A planned second stage, to increase capacity to 3.3 million tons per year, and costing $380 million, would be ready in the early 1980's.

The plant will be located at Las Truchas in the State of Michoacán. The port for the complex will be Lázaro Cárdenas, at the mouth of the Balas River on the Pacific Ocean. Dredging will be done under direction of the Navy Ministry and the dredged material used as fill at the plant site. Contamination of air and water is not expected to be a factor, since between 5% and 10% of total investment is to go for pollution control equipment.

The State-controlled Altos Hornos de México, S.A. was to add a second basic oxygen furnace and several arc furnaces in its short-term expansion program and reach a 4.4 million-ton capacity rate by 1975.

Fundidora planned basic oxygen furnace increases to obtain a 1.5-million-ton capacity figure by 1975. Japanese interest in the Mexican steel industry increased with purchase of 12% to 15% of Fundidora. Commitment by another Japanese group involving a new Mexican stainless steel plant was being considered.

A third sponge iron plant at Monterrey, was scheduled by Fierro Esponja. To be constructed by Swindell-Dressler Co. of the United States at a cost of $500 million, it would have an output of 1 million tons per year.

Netherlands.—The Dutch-West German steel combination, ESTEL N.V. (Hoesch-Hoogovens), announced plans to increase steelmaking capacity at IJmuiden by approximately 660,000 tons per year, or 10% above the 6.6 million-ton-per-year capacity of 1972. This expansion was expected to be sufficient to 1975–76, and would be used principally to supply the rolling mills at Dortmund, West Germany. A seventh blast furnace was started up at the IJmuiden complex during the year with a capacity of approximately 2.8 million tons per year.

The Dutch national steelworks Koninklijke Nederlandsche Hoogovens en Staalfrabrieken N.V., with facilities at IJmuiden concluded an agreement with Hoesch A.G. to form a common company on a financial level. Previously the two had attempted to obtain permission to construct a large, integrated steelplant on the reclaimed Maasvlakte area in Europort near Rotterdam. The plan was rejected by the city council under public pressure based on pollution problems.

South Africa, Republic of.—Construction of the steel mill complex at Newcastle by the Government-controlled South African Iron and Steel Industrial Corp. Ltd. (ISCOR) was well underway. Anticipated commissioning dates given for the new plant included 1974 for one coke oven battery of 2,500 tons per day and 1975 for a second. A 4,000-ton-per-day blast furnace would be commissioned in 1976. Total expenditures of about $1.5 billion have been planned for the complex, which would eventually employ 12,000 workers.

Expansion at the company's Pretoria works included a new oxygen steelmaking plant planned to be ready in 1976. At the Vanderbijlpark works, major projects scheduled for completion by 1976 included additional rolling mill capacity as well as blast furnace and melting plant capacity.

Spain.—Spanish steelmills recovered rapidly from the 1971 slowdown and ended the year with a 23% increase in raw steel production.

A concession was awarded to construct and operate the fourth integrated steelworks at Sagunto. The company approved for the project, Altos Hornos del Mediterraneo, was formed by Altos Hornos de Vizcaya S.A. and U.S. Steel Corp., the latter holding a 25-percent interest. Construction would be in three phases, extending through 1982 with capacity reaching 6 million tons of raw steel per year at that time. Included in the concession were several Government benefits, including essentially a total tax exemption for a period of 10 years. Investment for all phases was expected to reach $1.2 billion.

Continued expansion in the iron and steel sector is expected along with the country's industrial expansion. Apparent steel consumption was less than production for the first time in 1971, and exports of steel products are expected to become increasingly important in the future plans of this country.

Sweden.—The Government-owned steelworks, Norrbottens Järnverk AB (NJA) in Luleå, received approval to construct a coking plant at an estimated cost of approximately $71 million. This would supply coke for the expanding iron and steel operations at Luleå and provide an additional 200 jobs expected as a result of the project.

A contract for construction of a new blast furnace for Surahammars Bruks AB at its Surahammar plant was awarded to a British company. The company, a member of the Davy-Ashmore Group, would also furnish an oxygen converter. These units were scheduled for completion in 1974.

Sweden's iron and steel export trade amounts to about $1 billion. Special steel products are particularly significant, and Sweden has about 10% of the world market. Technological research in the fields of production, metallurgical processes, and equipment are heavily funded to maintain competitive advantage. Planned investments in the iron and steelworks sector for 1972 were estimated at approximately $39 million for plants and $143 million for equipment.

United Kingdom.—Implementation of the Government's plan for the British Steel Corp. (BSC) continued to be the major news in the iron and steel industry. The 10-year, $7.5-billion program to modernize the British steel industry was well underway, and some additional details were released. A loss of 50,000 jobs was expected as obsolete processing methods and plants were phased out. However, the strategic placing of factories to counter this job loss is an example of the planning which extends beyond consolidation of steel plants. Exact closure plans for the various steel plants would depend on market conditions and the country's future needs. With the United Kingdom joining the European Coal and Steel Community (ECSC), the official viewpoint was that BSC would have excellent growth prospects in a tariff-free market of 300 million people opening up over the next 4 years.

All of BSC's open-hearth furnaces would be closed by the end of the first 5 years of the plan, replaced by oxygen and electric-furnace steelmaking. Major construction was being done at the five integrated steelworks—Port Talbot, Llanwern, Lackenby, Scunthorpe, and Ravenscraig—and a new complex was being built at Teesside. All blast furnace pig iron production in the United Kingdom is controlled by BSC, as well as approximately 90% of its raw steel.

In the private sector new construction was in progress also. Programs included a new electric melting shop with vacuum refining furnaces; an electroslag remelting plant for Firth Brown Ltd.; and an argon-oxygen refining unit with a new ultra-power electric-arc furnace for Brown Bayley Steels Ltd., both at Sheffield. The fate of 27 open hearths remaining in the private sector was uncertain, but they could be expected to close out as BSC closes its 94 units.

A listing of the principal overseas investments of BSC International Ltd., a susidiary of BSC, was given.[5] The list included operations in Argentina, Canada, India, New Zealand, Republic of South Africa, and other countries.

Steelmaking, covering the next decade in northeast England was discussed in a two-part article.[6]

Mini-mill planning in the United Kingdom was active with one opened in 1972

[5] Metal Bulletin. BSC International. No. 5744. Oct. 24, 1972, p. 30.

[6] Iron and Steel. Steelmaking in North-East England. V. 45, No. 1, February 1972, pp. 59–60 and pp. 61–71.

and four scheduled or being planned for operation in the next few years.[7]

U.S.S.R.—Production of raw steel continued to increase at the 4% to 5% growth rate of the past few years, and additional capacity was underway in accordance with the current Soviet 5-year plan (1971–75). This plan placed production at 161 million tons in 1975, the target year.

New additions completed or underway at iron and steelmaking plants included a large blast furnace using natural gas injection, and basic oxygen converter facilities for the Novo-Lipetsk Iron and Steel Works at Lipetsk. Another blast furnace underway for the Krivoy Rog works in the Ukraine will have a volume of 177,000 cubic feet. Additional basic oxygen facilities were due to start up in 1973 at the Western Siberian Steel Works near Novokuznetsk.

Two developments expected to be of increasing importance to the steel industry are the tremendous natural gas reserves being developed and the increase in trade with the western world. The gas reserves are such that agreements have been signed with a number of European countries for 20-year periods. Future sales also may be made to Japan and the United States. Swedish studies made in 1972 included the feasibility of obtaining Soviet natural gas via a pipeline across the Baltic from Finland. Possible availability of Soviet gas would increase chances for direct reduction of iron at a number of locations. Present U.S.S.R. gas production used includes approximately 14% for iron and steelworks. Plans to construct a large steelworks at Kostamuska near the Finnish border has been announced with capacity as much as 5 million tons per year. Natural gas would be used for fuel and reductant in direct reduction units.

A contract for a turnkey steel materials plant was concluded with a combine of two American and three British companies. The plant will have five production lines and go on stream in 1975. Additional contracts were made for other specialized steelmaking equipment to be supplied by American and British firms.

Reportedly, sales of specialized Soviet-made steel mills were made to U.S. steelmakers. These were concluded following U.S. Patent Office approval of the Soviet inventors' applications for U.S. patent coverage.

TECHNOLOGY

Blast Furnace.—The trend toward large capacity blast furnaces appeared well established following continued successful Japanese operation of the 10,000-ton-per-day type in several plants. Japan started up two of this type in 1972, one rated at 11,000 tons per day, and another was expected to be operational in 1973. The U.S.S.R. was constructing two units designed for natural gas injection, which would average about 12,000-ton-per-day capacity.

Other countries having somewhat smaller designs included West Germany the Netherlands, France, and the United States. On completion, U.S. Steel Corp.'s 10,000-ton-per-day blast furnace at Gary, Ind. will replace five of the plants' older existing blast furnaces.[8]

Blast furnaces installed, under construction, or planned in the world increased by 28 during 1972. Japan had five new installations, the U.S.S.R. three, and one each in the United Kingdom, West Germany, and the United States. The average capacity of the units in Japan was approximately 4 million tons per year, and worldwide 2.89 million tons per year per blast furnace.

The Kaldo furnace appeared to be on the way out in the United States as Sharon Steel Corp. scheduled replacement of its installation at the Farrell works with top-blown basic oxygen converters.

A two-part review of the thermodynamics and kinetics of basic oxygen steelmaking and application of theoretical knowledge was published.[9]

Basic Oxygen Process (BOP).—The BOP's share of domestic steel production increased further in 1972 to 56%, from 53% in 1971. Capacity of the process was estimated at 82 million tons, and total

[7] Metal Bulletin. UK Mini Mill Projects. No. 5764, Jan. 5, 1973, p. 28.

[8] Iron and Steel Engineer. Annual Review—Developments in the Iron and Steel Industry During 1972. V. 50, No. 1, January 1973, p. D31.

[9] Walker, R. D. and D. Anderson. Reaction Mechanisms in Basic Oxygen Steelmaking. Part 1. Iron and Steel, v. 45, No. 3, June 1972, pp. 271–276; Part 2 , v. 45, No. 4, August 1972, pp. 403–407.

world capacity at 370 million tons per year. Japan produced 79% or 84.9 million tons of its total 106.8 million tons of raw steel by the basic oxygen method in 1972.

The U.S. Steel Corp. had under construction at its Gary, Ind., and Fairfield, Ala., works bottom-blown oxygen converters. This modification of the oxygen process, known as Q-BOP, or QBM in Europe, has been licensed by the West German developer Maxhütte, and is in use in several European steelplants. One South African plant, ISCOR's Pretoria works, also has a commercial installation. Scheduled future investments indicated possible acceptance and gradual growth of the process. The principal innovation involves a double concentric tuyere arranged to allow central injection of pure oxygen shielded by an injected fluid hydrocarbon, either gaseous or liquid. Wear on refractory parts are reduced, pneumatic mixing accomplished, and greater oxygen efficiency achieved.

An innovation to the bottom-blown oxygen process for use in open-hearth furnaces was announced by Canada's Sydney Steel Corp. The process designated as the submerged injection process (SIP) uses the same tuyere construction employed by the Q-BOP or QBM process. International development would be handled by Maxhütte and technical developments in North America by Pennsylvania Engineering Co.

Electric Furnaces.—Production of raw steel in the United States by the electric arc furnace method increased over the previous year by 0.4% to 17.8% of the total. Although the percentage gain appeared low, an additional 30 furnaces were scheduled for completion by the iron and steel industry by 1974. Total electric furnace capacity was estimated at 32 million tons in 1972.

CF&I Steel Corp. had a new melt shop under construction at a cost of $13.5 million. This would have a 150-ton electric furnace and be ready in 1973. Lukens Steel Co. also had new electric melting facilities started, which included a 150-ton electric furnace, at a total cost of $18.8 million. The facilities would incorporate charging techniques to allow use of prereduced iron pellets and lessen dependence on scrap. The Ford Motor Co., Steel Division, had an electric furnace shop under construction which would contain two 200-ton electric arc furnaces. Smaller furnaces were being installed for a number of other steel and foundry companies.

The use of electric furnaces for small steelworks or mini-mills continued to increase in most areas of the world. In France three groups were formed to build mini-mills in that country, with a fourth project under consideration. Privately funded mini-mills announced for the United Kingdom will average at least one per year for the next 4 years. This expansion could eliminate what has been an annual scrap surplus in the United Kingdom. The BSC has started a study of the place of mini-mills in British steelmaking and, in a recent article, one of the United Kingdom's leading authorities indicated that 25% of that country's steel products might possibly be made on a mini-mill scale.[10]

The performance measurement of electric arc furnaces in steelmaking was discussed in an article,[11] and a method referred to for specifying conditions for lowest cost operation. One conclusion was that although practicable to operate a 400-ton arc furnace in the United States, it would not be recommended for the United Kingdom.

Future prospects for the arc furnace in steelmaking was outlined in a paper which was reviewed at the International Electroheat Congress in Warsaw.[12] Some results of continuously charging prereduced pellets to an electric furnace were given. Power consumption for test pellets 93.6% metallized and containing 92.2% total iron was given on a comparative basis as 585 kw-hr per metric ton and 500 kw-hr per metric ton for an all-scrap charge.

The techniques involved in determining the best process to be used for steelmaking, that is, the electric furnace versus the basic oxygen converter, as well as equipment selection for a particular situation, were discussed in an article.[13]

Iron and Steel Refining.—Additional argon-oxygen deoxidation (AOD) refining

---

[10] Cartwright, Fred. Challenge of the Mini-Mills. Iron and Steel Review (India), v. 16, No. 6, November 1972, pp. 17–21.

[11] Davies, D. R. G., and A. H. Leckie. Performance Measurement—The DAP Concept. Journal of the Iron and Steel Institute, v. 210, Part 11, November 1972, pp. 817–825.

[12] Harrison, W. L., Electro-heat for the Iron and Steel Industries. Iron and Steel, v. 46, No. 1, February 1973, pp. 65–68.

[13] Kuhl, R. J. Selecting Processes and Equipment. J. Metals, v. 24, No. 6, June 1972, pp. 40–45.

facilities were started up in the United States and the United Kingdom, and units were under construction in other countries. Fried. Krupp Hüttenwerke A. G. was licensed to use the Union Carbide process and will have the first installation in West Germany.

In Sweden, Uddeholms AB reported on a modification involving the use of superheated steam to replace argon in the AOD process. A commercial installation was expected to be ready for operation in 1973 and reportedly would cut $8 per ton from the cost of producing stainless steel ingot.[14] Uddeholms will use bottom blowing in operation of the first converter at its Degerfors, Sweden, plant.

Electroslag remelting and refining (ESR) continued to attract attention, and a furnace installed at Sweden's Avesta Jernverks AB plant was capable of producing 10-ton stainless steel ingots. The increased interest in this process was tied to a trend toward increasing demand for superclean grades of stainless steel. Increased strength of the ESR steels were given as a big factor to consider along with lower production costs in comparison with other vacuum refining methods.

Lukens Steel Co.'s new ESR facility was discussed in an article from a standpoint of product qualities obtained by use of the method.[15] Slabs up to 30 tons and measuring 30 inches by 80 inches were produced in 1972.

Allegheny Ludlum Steel Corp. reported on two new stainless steel refining methods at the annual AISI meeting. Both were developed by the company. The first involved melting in a hot-blast cupola and transferring the hot metal to a BOP converter. Temperature in the bath rises to above 3,450° F at the end of an oxidation period resulting in low-carbon metal and minimum chromium losses. A second process, the Allegheny vacuum refining (AVR) process was reportedly used to decarburize charges of stainless steels previously melted in arc furnaces. Oxygen is injected below the surface of the metal while it is held under reduced pressure. Improved chromium yield over conventional air-melt practice is obtained.[16]

General reviews covering methods of vacuum treatment of steel during recent years, and some of the technical innovations involved were discussed in two articles.[17]

Direct Reduction.—Detailed coverage was given the state of the art at a seminar on direct reduction of iron ore held in Bucharest, Romania, September 18–23. The seminar, sponsored by the Economic Commission for Europe (ECE) covered developments of processes, and discussed to some extent their economic aspects. There were 142 speakers in the discussions and participants from 33 countries.

Total operating world capacity for prereduction was given as 2.86 million tons including partial prereduction. Capacity of plants under construction or expected to operate by 1974 would add an additional 3 million tons. This included U.S. Steel Corp.'s direct reduction plant in Venezuela, and Armco Steel Corp.'s plant near Houston, Tex. Both of these plants were in the process of eliminating startup problems prior to full-scale operation.

The first integrated steelworks in Western Europe using direct reduction was opened officially in April. This complex, Hamburger Stahlwerke, G.m.b.H., was reported to have an investment cost of approximately $120 per ton of annual capacity.[18] A description of major units of the plant were given.

The direct reduction plant constructed in Canada by Falconbridge Nickel Mines Ltd. to produce iron-nickel pellets closed in 1972. The plant first operated in 1971 and reached a maximum production rate of two-thirds of the annual design capacity prior to being shut down because of economic reasons.

A direct reduction plant for Western Australia was being studied by the Minister of Mines who discussed proposals with ATH officials in West Germany and visited the firm's Purofer plant.

An evaluation of prereduced materials

[14] Engineering and Mining Journal. New Stainless Steel Process Will Be Underway in 1973. V. 173, No. 10, October 1972, p. 9.

[15] Metal Progress. ESR Process Makes Large, Clean Plates. V. 102, No. 5, November 1972, pp. 68–70.

[16] Iron Age. Chromium Recovery Improved in Stainless Refining. V. 209, No. 23, June 8, 1972, pp. 59, 60.

[17] Thornton, D. R. Vacuum Degassing and Allied Processes. Steel Times, v. 200, No. 10, October 1972, pp. 737–741.

Messing, I. T. Modern Vacuum Plants for Metallurgical Treatment of Steel. Steel Times, v. 200, No. 11, November 1972, pp. 813–817.

[18] Crawford, C. W. J. Europe's First DR-Integrated Steelworks. Steel Times, v. 200, No. 7, July 1972, pp. 539–542.

and trends for future steelmaking use were presented in an article along with brief discussions on some electric arc furnace tests. Trials using both pelletized and briquetted prereduced material were successful, with briquetts having a metallization in the 90% to 92% range giving excellent results.[19]

Continuous Casting.—Japan led the world in percent of raw steel production continuously cast with approximately 25% produced by this method. There were 63 casting machines with 146 strands operating in Japan. The U.S.S.R. led in number of units with 73 machines and 173 strands.[20] The United States operated 58 machines with 152 strands and continuously cast an estimated 5% to 6% of its raw steel production.

The largest continuous casting mill in Japan was at the Kashina works of Sumitomo Metal Industries, Ltd., where annual production of two strands was given at 1.3 million tons. In the United States, McLouth Steel Corp. was handling its entire output of steel with four single-strand casters. The capacity of the system was rated at 2.4 million tons per year. No ingots were being cast. The Gary works of U.S. Steel Corp. cast 22,391 tons of steel in its continuous-caster during an 83-hour period with no interruptions to set a record. Several grades of steel and 27 different cross-sectional sizes were cast during this period. Yield of prime slabs was reported as 98.6%.

Eastern Stainless Steel Co., as part of a modernization program, planned to continuously cast its output of stainless steel. A $7.6 million system will be in operation by 1974. Concast Inc. and Wean United Inc. agreed to cooperate in the development of continuous casting machines. Wean was to manufacture equipment under patents held by Concast.

In the United Kingdom, development of a horizontal continuous caster had reached pilot plant stage with good results reported. Saving over conventional methods was said to be significant. The U.S.S.R. was reported to have a large-scale horizontal unit operating.

Continuous casting units continued to be planned for and installed in a large number of countries throughout the world. These included Mexico, Canada, France, Italy, Sweden, India, Republic of South Africa, and Malaysia.

Powder Metallurgy.—Iron and steel powder producers were looking for substantial growth in the future, as technology of powder metal (PM) parts-forming processes improved. An official of Hoeganaes Corp., 80% owned by Interlake, Inc. and a leading producer, forecast iron powder shipments in 1980 at 310,000 tons.[21] This forecast was based on the assumption that hot forming of PM parts would reach large-volume proportions. The company indicated that continuing research and development would be carried out in the development of processing parameters as well as improved powders.

The potential of dense parts, mass produced from iron or iron-base powders, appeared good. High-density PM gears, containing 2% nickel, after sintering, heat treating, and tempering, attained yield strengths to 110,000 psi. Relating to concerns of the Occupational Safety and Health Administration, low-density iron powder for metallic brake linings was proposed to replace asbestos, a material which is cited as presenting industrial health problems.

General Motors Corp. Research Laboratories reported inexpensive powder produced from plant-generated machining and lathe turnings. Designated as Macromesh, the material was being considered as starting material for preforms; although coarser than conventional iron powders, the machining characteristics of the original stock are maintained.

A Ford Motor Co. official, in a speech to Forging Industry Association members at a Montreal meeting, reported that tests on various auto components from powdered metal looked good and cited the entire gear train as a potential use. The high cost of powdered metal was said to be a factor in holding the use down.

The production of high-speed tool steel from powder by a new economical process was announced by a company which made use of water atomization instead of gas, followed by an inexpensive process of con-

[19] Jensen, Harold B. Current Status of the Use and Production of Prereduced Iron. Iron and Steel Engineer, v. 49, No. 11, November 1972, pp. 59–66.

[20] Journal of Metals. USSR and Japan—1–2 in Casting. V. 24, No. 12, December 1972, p. 4.

[21] Holmes, R. R. Powder Metallurgy Entering a New Era. Amer. Metal Market, v. 79, No. 75, Apr. 18, 1972, pp. 11, 15.

verting the powder into billets. The lower cost advantage, plus uniformity and improved cutting qualities permitted, was expected to result in PM tool steel products competitive with those from conventional processing.

Latest technical advances in providing equipment to eventually make possible continuous automatic production from powder to the finished component was discussed at a design and research conference held in Birmingham, England.[22] A U.S.S.R. paper discussed the use of hydrodynamic production of powder preforms and reported that iron powder compacts produced with 10% to 15% higher tensile strength than those statically formed could be further raised to 30% by using explosives.

Production of iron-base powders by a Canadian plant with a capacity of 70,000 tons per year was discussed in a publication.[23] Properties of products obtainable under various conditions were described.

Foundry.—Foundry trends were toward modernization with fewer but larger installations. More electric furnace melting at the expense of the cupola was indicated for the future, although large cupolas incorporating advanced technology, including pollution controls, were being planned or installed in increasing numbers. One usually would replace a number of smaller and less efficient units.

American Cast Iron Pipe Co. (ACIPCO) brought on stream a 150-inch-diameter, waterwall cupola with a melting capacity of 105 tons per hour of gray iron or 85 tons per hour of steel mix for ductile iron. Electric holding furnaces and a process control computer were installed to allow maximum process variable control and more economical operation. Another feature was air pollution control equipment designed to remove 99% of the furnace's particulate emissions. Total cost of the new facility was $6 million, of which pollution control equipment accounted for $1 million.

Pollution control continued to be of particular concern to the foundry industry because of relatively high capital costs for bringing equipment into compliance with the Occupational Safety and Health Act (OSHA). In a survey by Foundry,[24] the industry report showed that only 22% of the respondents considered their operations to meet the standards, with 21% not knowing, and 57% reporting standards as not being met. Plants expecting to purchase equipment of some type in 1973 totaled 74%, with 32% to purchase pollution control devices.

Oxygen enrichment of cupolas, although not new, was being reexamined as a partial solution to rising coke prices as well as air pollution restrictions. A detailed study of nine operations was made available by Airco Industrial Gases comparing normal operations with operations using oxygen injection. An average reduction of 41 pounds of coke was reported in injections ranging from 625 to 1,320 cubic feet of oxygen per ton of iron produced.[25]

The 39th International Foundry Congress was held in Philadelphia, Pa., May 8–12, and papers were presented covering several areas of technical progress. One paper dealt with large steel castings for nuclear reactors and the tests required for these; another with techniques used in surface coating of cast iron with alloys during casting.

A European converter process for making ductile iron and using metallic magnesium for nodulizing was described.[26] The new process utilized a special vessel, and was reported to allow simultaneous magnesium treatment, desulfurization, and carburization. Cost savings were cited over other nodulizing processes.

In England, the use of a novel rotary furnace using fuel oil was proposed for melting gray iron. Comparison of fuel consumption figures with a cold-blast furnace using coke and with an induction furnace using electricity indicated possible advantages in fuel cost and pollution controls. A 1-ton furnace required a melt time of 1½ hours with a firing rate of 30 gallons of

---

[22] Whittaker, D. Powder Forging New Key for Precision Parts Making. Amer. Metal Market, v. 79, No. 180, Oct. 2, 1972, p. 7.

[23] Capus, J. M. Iron Powder for High Strength Sintered Steels. Metallurgia and Metal Forming, v. 40, No. 1, January 1973, pp. 23–26.

[24] Foundry. 1973 Outlook: 11.5% Increase. V. 101, No. 1, January 1973, pp. 42–45.

[25] Iron Age. Tired Old Cupolas Rely on Oxygen for a Second Wind. V. 210, No. 25, Dec. 21, 1972, pp. 52, 53.

[26] Alt, A., K. Gut, H. A. Lustenberger, and H. G. Trapp, (Translated by H. Heine). Producing Ductile Iron with Metallic Magnesium. Foundry, v. 100, No. 7, July 1972, pp. 55–57.

oil per hour to provide a ton of molten iron from cold metal.[27]

Research and Development.—Projects connected with iron and steelmaking were active at four Bureau of Mines Metallurgy Research Centers during the year. The production of steel from urban refuse, and the control of detrimental effects in steels containing tramp copper were two projects under study at the Albany Metallurgy Research Center. The Rolla Metallurgy Research Center was studying hot rolling and forging of ductile iron, and the production of recyclable iron products from mill scale and from steelmaking and iron foundry dust. At the Twin Cities Metallurgy Research Center, projects to determine minimum use of fluorspar in basic oxygen steelmaking and evaluations of possible substitutes were underway. Another project had as its objective the production of commercial grades of pig iron from low-grade ferrous scrap. The College Park Metallurgy Research Center operated a new, 5-ton-per-hour pilot plant to handle raw refuse, and along with other products, recover light iron, including tin cans, and heavy iron. Additional research was started to devise methods of utilizing the ferrous fractions as charge material for the electric-arc steelmaking furnace, and in producing a commercial-grade pig iron.

Other ferrous research projects included one at the University of Michigan on leaching of copper from steel scrap. The University of Pennsylvania's metallurgy department worked on the iron-copper-carbon system and results suggested a possible liquation process for separating copper and iron in copper-bearing steel scrap.[28] A review of use of rare earths in the high-strength low-alloy (HSLA) steels was published; the United States is a basic supplier of rare-earth raw materials to the rest of the world.[29]

Stainless steel producers reported continuing research and development studies of new types of steels for high-temperature and corrosion applications for an expanding stainless market. One new austenitic stainless steel produced by Armco was said to have corrosion resistance superior to type 316 steel, among other properties.[30]

Shaped tin-free steel beverage cans were in test production using a new patented process involving deep drawing of the steel. This process was expected to permit the economical substitution of steel cans for a large segment of the beverage market now serviced by aluminum. For coated steels, the powder coating method was moving from the laboratory into test production. Several manufacturers, including automotive manufacturers, had started field tests.[31] The substitution of dry plastic coatings for liquid coatings of metal was also being studied as a substitute for galvanized steel. Patents held by General Electric's Lamp Metals and Components Department were being used by a company formed for the purpose of die casting ferrous metals. Die cast tools were said to be lower in cost than those produced by powder metal tool methods.

The Ford Motor Co., to improve productivity and quality of the products, was instituting automated pouring equipment in its new iron foundry. Automatic pouring, a recently developed technique, is expected to be specified for all new high-volume casting plants in the future. The American Steel Foundries, subsidiary of Amsted Industries, planned to invest more than $300,000 in new facilities to test freight car components in the company's Illinois product development and test laboratory. This laboratory operates one of the largest railroad research programs in the country.[32]

The development of continuous steelmaking was kept alive by the operation of the IRSID plant at the Hagondange works of Wendel-Sidélor in France. The 25-ton-per-hour continuous steelmaking unit produced over 20,000 tons of steel of various grades since the start of operation in 1971.[33]

In the United Kingdom, BSC continued to reorganize its research laboratories. In

[27] Metallurgia and Metal Forming. Melting Cost and Environmental Considerations. V. 39, No. 7, July 1972, pp. 233–235.
[28] Chemical and Engineering News. Universities Grapple with Mineral Processing. V. 50, No. 6, Feb. 7, 1972, pp. 25–28.
[29] Cannon, Joseph G. How the Rare Earth Metals are Making it in Steel. Amer. Metal Market, v. 79, No. 233, Dec. 20, 1972, pp. 1-A–8-A.
[30] Gaugh, R. R. and D. C. Perry. A New Stainless Steel for the CPI. Chemical Engineering, v. 79, No. 22, Oct. 2, 1972, pp. 84–90.
[31] Iron Age. Powder Coating: 'A Finisher's Finish.' V. 210, No. 20, Nov. 16, 1972, pp. 67–74.
[32] American Metal Market. American Steel Foundries to Build Comprehensive Rail Test Facility. V. 79, No. 1, Jan. 3, 1972, p. 5.
[33] Coche, L. and B. Trentini. Industrial Development of the IRSID Continuous Steelmaking Process. Iron and Steel, v. 45, No. 4, Aug. 1972, pp. 408–410.

addition to the corporate laboratories, responsible to the director of research and development, there were to be research departments in each product division. These would be organized as follows: (1) The strip mills division would concentrate all of its research work at the Port Talbot laboratories; (2) the general steel division would construct a new laboratory near Middlesborough; (3) the special steels division would reorganize work in the Swinden laboratories at Rotherham, and in addition, would serve as the physical metallurgy center for the corporation as a whole; (4) the tubes division would have its research organization centered at Corvey, and also maintain four branches. The corporate laboratories have been completely reorganized. They evolved largely from the former BISRA organization and now consist of three separate laboratories: (1) the advanced process laboratory at Teesside concerned with new methods of iron and steelmaking; (2) the corporate development laboratory at Sheffield engaged in new ventures which do not fall within the interests of a particular division; and (3) the corporate engineering laboratory at Battersea, London, which is involved mainly in development and design of improved steelworks plant and engineering systems. In addition, a number of centers have been created with special duties such as nondestructive testing. As part of BSC's large-scale development work, a blast furnace operation using formed coke ran for 5 days with 100% replacement of conventional coke without any noticeable change in operating characteristics. These results and former tests indicated that the formed coke, or briquetted material could be used on a 100% basis although the gross fuel requirement would be increased to some extent. Flue dust losses increased but created no problems in the gas cleaning system.

In Japan MITI announced plans to start a 6-year program for development of a nuclear-powered steel mill system to begin in 1973. Plans included development of a pilot system to produce reduced iron containing 95% or more Fe by utilizing the nuclear heat. The latter project would have a funding of $26 million. A new system to desulfurize pig iron was announced by Sumitomo Metal Industries. This system involved the use of a sloped rotary kiln in which the desulfurizing reagents were added and rotated for 2 to 4 minutes with the molten iron. Reduction of pig to less than 0.005% sulfur content was claimed.

The use of magnesium to desulfurize molten steel was entering the developmental stage in the United States, and was expected to be in general use as soon as injection problems were solved.

Another method of desulfurizing molten pig iron came from West Germany with the announcement of August Thyssen-Hütte A.G. of an experimental operation performed at its Beeckerwerth steelplant. This operation involved calcium carbide injected by lance into the molten pig iron on a molten metal car as it is moved from the blast furnace to the steel furnace.

In Sweden the Metallurgical Research Station in Luleå built a blast furnace simulator which permits the study of the molten metals in the range of 1,000° to 1,500° C., and allows the study of the different materials under controlled conditions.

Pollution Control.—In 1972 the domestic steel industry placed in operation pollution abatement equipment costing $202 million. Since 1965 the industry has invested $1.3 billion and has budgeted for the future $336 million for control equipment installations. Industry experts estimated that the cost per year to maintain the equipment would be approximately 12% of the original construction cost. Approximately 60% of the cost for control installations has been for air purification and the remainder for water quality control. Although all steel producers were moving to meet the standards set by the quality control act of 1970, the ability of the industry to provide the capital, meet operating costs of pollution control equipment, and continue to install necessary processing equipment without substantial price increases on products was questioned.[34] The resolution of the environmental problems facing the industry will be of primary concern to all steelmakers in the next few years, along with the problem of steel imports.

The iron and steel foundries were no less concerned over increased costs owing to environmental control requirements than the steelmakers. Many of the smaller

[34] Industry Week. EPA, Steel Tiff Over Cleanup Costs May Be First of Many. Nov. 6, 1972, pp. 18–20, 58.

foundries have been forced to cease operations because low-profit margins did not allow installation of necessary pollution control equipment. Where possible, cost increases will be passed on to consumers and the foundry will install the needed equipment. However, it was indicated that a substantial amount of smaller foundry production will be assumed by the larger foundries and a part imported as castings before the environmental standards compliance is resolved. The effect of environmental control on cost of domestic castings has been given at from more to $14 per ton for the smaller foundries to under $2 per ton for the larger ones.

Iron foundry population was projected to continue to decline to about 1,000 in 1980, although production trends are for a continuing growth rate projected at 2% per year.[35] Domestic iron and steel foundries in 1972 numbered approximately 1,900.

One method that has been gaining the favor for the reduction of air pollution in plants producing ductile iron has been the use of new nodulizers, such as Remag, a magnesium-containing additive developed by the U.S. Pipe and Foundry Co. This type of product is reported to sharply reduce fume and visible flare during the addition operations.

A paper on air pollution control in the British iron and steel industry presented at the last International Pollution Control and Noise Abatement Conference held in Sweden, was reproduced for discussion.[36] Systems used for the various steelmaking processes were covered.

A new vacuum, two-stage steelmaking process developed in Sweden by SKF Stål was publicized as having a very low level of environmental pollution, as well as a higher utilization of electric power and equipment than conventional electric-arc methods.[37]

In Japan the outlay for pollution control planned by the six major steelmakers amounted to approximately $280 million for Japanese fiscal year 1973, compared with $265 million in Japanese fiscal year 1972. The investments by the six firms was about 15% of total investments for the plants. MITI was studying various measures to control air pollution and set the time table for sulfur dioxide emission standards compliance ahead by 1 year. A 0.015 parts per million standard also was adopted for SO_2.

[35] Gutow, B. S. Impact of Foundry Pollution. Environmental Science and Technology, v. 6, No. 9, September 1972, pp. 790, 792, 793.
[36] Speight, G. E. Air Pollution Control in the British Iron & Steel Industry. Steel Times, v. 200, No. 5, May 1972, pp. 395–402, 407.
[37] Carden, P. New Steelmaking Process Gives Low Environmental Pollution. Steel Times, v. 200, No. 3, March 1972, p. 297.

Table 2.—Pig iron produced and shipped in the United States, in 1972, by State
(Thousand short tons and thousand dollars)

State	Production	Shipped from furnaces		Average value
		Quantity	Value	
Alabama	4,086	4,083	277,745	68.03
Illinois	7,196	7,198	542,883	75.42
Indiana	15,329	15,335	1,180,112	76.94
Ohio	16,364	16,471	1,300,278	78.95
Pennsylvania	20,356	20,374	1,629,330	79.97
California, Colorado, Utah	4,733	4,770	385,855	80.89
Kentucky, Maryland, Texas, West Virginia	9,938	9,908	784,798	79.21
Michigan, Minnesota	6,929	6,931	497,891	71.83
New York	3,933	3,978	291,966	73.40
Total	88,864	89,048	6,890,858	77.38

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	1971 [1]	1972 [2]
Australia	729	867
Brazil	62	297
Canada	1,677	1,815
Chile	370	324
Venezuela	4,376	4,058
Other countries	198	698
Total	7,412	8,059

[1] Excludes 18,466 tons used in making agglomerates.
[2] Excludes 6,054 tons used in making agglomerates.

Table 4.—Pig iron shipped from blast furnaces in the United States, by grade [1]

(Thousand short tons and thousand dollars)

Grade	1971			1972		
	Quantity	Value		Quantity	Value	
		Total	Average per ton		Total	Average per ton
Foundry	r 1,473	r 98,472	r 66.85	1,417	97,884	69.08
Basic	r 76,233	r 5,354,202	70.23	83,809	6,505,353	77.62
Bessemer	1,295	91,916	70.98	1,269	94,835	74.73
Low-phosphorus	153	10,900	71.24	105	7,966	75.87
Malleable	1,935	139,502	72.09	1,998	149,348	74.75
All other (not ferroalloys)	243	17,049	70.16	450	35,472	78.83
Total	81,332	5,712,041	70.23	89,048	6,890,858	77.38

r Revised.
[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, 1972			Jan. 1, 1973		
	In blast	Out of blast	Total	In blast	Out of blast	Total
Alabama	8	8	16	9	8	17
California	4	--	4	4	--	4
Colorado	4	--	4	4	--	4
Illinois	13	6	19	10	7	17
Indiana	18	7	25	21	5	26
Kentucky	2	--	2	2	--	2
Maryland	4	6	10	7	3	10
Michigan	8	1	9	8	1	9
Minnesota	1	1	2	--	2	2
New York	6	9	15	8	6	14
Ohio	22	21	43	29	14	43
Pennsylvania	26	29	55	32	23	55
Texas	1	1	2	1	1	2
Utah	2	1	3	2	1	3
West Virginia	4	--	4	4	--	4
Total	123	90	213	141	71	212
Ferroalloy blast furnaces	3	--	3	2	--	2
Grand total	126	90	216	143	71	214

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)

Year and State	Metalliferous materials consumed: Iron and manganiferous ores: Domestic	Iron and manganiferous ores: Foreign	Agglomerates	Net ores and agglomerates[1]	Net scrap[2]	Miscellaneous[3]	Net total	Net coke	Fluxes	Pig iron produced	Metalliferous materials consumed per ton of pig iron made: Net ores and agglomerates[1]	Net scrap[2]	Miscellaneous[3]	Total	Coke and fluxes consumed per ton of pig iron: Net coke	Fluxes
1971:																
Alabama	810	W	4,140	6,480	124	9	6,613	3,001	792	3,946	1.642	0.031	0.002	1.676	0.761	0.201
Illinois	W	--	8,970	10,225	171	229	10,625	4,072	1,132	6,500	1.573	0.026	.035	1.634	.626	.174
Indiana	W	W	17,950	19,392	329	670	20,391	7,014	1,532	12,695	1.528	.026	.053	1.606	.553	.121
Ohio	3,666	715	16,820	20,682	565	1,412	22,659	8,922	2,725	13,703	1.509	.041	.103	1.654	.651	.199
Pennsylvania	5,608	3,201	20,857	28,527	812	1,343	30,682	11,775	2,446	18,812	1.516	.043	.071	1.631	.626	.130
California, Colorado, Utah	2,301	W	W	7,492	59	132	7,683	2,738	715	4,492	1.668	.013	.029	1.710	.610	.159
Maryland, West Virginia, Kentucky, Texas	W	W	13,412	r 15,049	184	773	r 16,006	6,102	984	9,772	1.533	.019	.079	1.631	.624	.101
Michigan and Minnesota	497	W	10,660	10,924	227	133	11,284	4,540	1,300	7,283	1.500	.031	.018	1.549	.623	.178
New York	1,447	107	W	6,555	179	165	6,899	2,630	688	4,179	1.569	.043	.039	1.651	.629	.165
Total	17,542	r 7,903	102,675	r 125,326	2,650	4,866	r 132,842	50,794	[4] 12,314	81,382	1.539	.033	.060	1.632	.624	.151
1972:																
Alabama	550	W	4,283	6,572	143	7	6,722	2,995	733	4,086	1.608	.035	.002	1.645	.733	.179
Illinois	W	--	10,193	11,315	211	327	11,853	4,303	1,133	7,196	1.572	.029	.045	1.647	.598	.157
Indiana	W	W	22,675	23,772	222	673	24,667	8,073	1,866	15,329	1.551	.014	.044	1.609	.527	.122
Ohio	4,840	848	20,002	25,007	510	1,225	26,742	10,266	3,354	16,364	1.528	.031	.075	1.634	.627	.205
Pennsylvania	5,238	3,161	23,618	31,612	761	1,270	33,643	12,755	2,408	20,356	1.553	.037	.062	1.653	.627	.118
California, Colorado, Utah	1,621	19	W	7,785	145	152	8,082	2,799	745	4,733	1.645	.031	.032	1.707	.591	.157
Maryland, West Virginia, Kentucky, Texas	832	1,384	13,833	15,621	30	765	16,416	6,116	1,220	9,938	1.565	.003	.077	1.645	.615	.123
Michigan and Minnesota	122	30	10,226	10,226	458	58	10,742	4,060	948	6,929	1.476	.066	.008	1.550	.586	.137
New York	1,080	30	W	6,000	248	191	6,439	2,472	559	3,933	1.526	.063	.049	1.637	.629	.142
Total	16,285	8,059	116,112	137,910	2,728	4,668	45,306	53,839	[5] 12,966	88,864	1.551	0.31	.031	1.634	.606	.146

r Revised. W Withheld to avoid disclosing individual company confidential data; included with 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: 6,211 limestone, 7 burnt lime, 5,736 dolomite, and 360 other fluxes excluding 4,154 limestone, 3,166 dolomite, and 139 other fluxes used in agglomerate production at or near steel plants and an unknown quantity used in making agglomerates at mines.
[5] Fluxes consisted of the following: 6,171 limestone, 360 burnt lime, 6,068 dolomite, and 366 other fluxes excluding 4,763 limestone, 40 burnt lime, 3,427 dolomite, and 113 other fluxes used in agglomerate 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 process	Electric	Total
1968	[3] 65,836	48,812	16,814	131,462
1969	60,894	60,236	20,132	141,262
1970	48,022	63,330	20,162	131,514
1971	35,559	63,943	20,941	120,443
1972	34,936	74,584	23,721	133,241

[1] Excludes castings produced by foundries not covered by AISI.
[2] Basic and acid open hearth production data reported separately in previous years.
[3] Includes Bessemer type furnaces.

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			
1968	958	2,514	684	337	79,948	1,676	67,281
1969	710	2,121	487	512	84,187	1,775	74,343
1970	502	1,889	465	476	81,797	1,641	66,451
1971	308	1,166	294	320	r 76,422	1,447	63,308
1972	236	850	401	192	82,979	1,655	73,469

r Revised.
[1] Basic oxygen converter, open-hearth furnace, and electric furnace. Bessemer included in 1968 only.
[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	1970		1971		1972	
	Thousand short tons	% of total	Thousand short tons	% of total	Thousand short tons	% of total
Basic oxygen converter	51,730	59.8	52,023	66.2	60,233	69.9
Open hearth	32,204	37.2	23,574	30.0	22,375	25.9
Electric	453	.5	825	1.0	961	1.1
Cupola	2,076	2.4	1,865	2.4	2,264	2.6
Air	94	.1	60	.1	139	.2
Other furnaces [2]	10	--	204	.3	254	.3
Total	86,567	100.0	78,551	100.0	86,226	100.0

[1] Excludes molten pig iron used for ingot molds and direct castings.
[2] 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	1972
Alabama	3,628
Connecticut	14
Georgia	7
Illinois	7,109
Indiana	15,118
Iowa	27
Kansas	2
Kentucky	1,729
Louisiana	(2)
Maine	(2)
Massachusetts	22
Michigan	7,527
Missouri	18
Montana	(2)
Nebraska	(2)
Nevada	(2)
New Jersey	58
New York	3,660
North Carolina	6
Ohio	16,108
Oklahoma	8
Oregon	2
Pennsylvania	20,873
Rhode Island	4
Tennessee	85
Texas	1,146
Vermont	3
Washington	2
Wisconsin	119
Undistributed [3]	11,865
Total	89,140

[1] Includes molten pig iron used for ingot molds and direct castings.
[2] Less than ½ unit.
[3] Includes California, Colorado, Florida, Maryland, Minnesota, New Hampshire, South Carolina, Utah, Virginia, and West Virginia.

Table 11.—U.S. exports of major iron and steel products

Products	1968 Short tons	1968 Value (thousands)	1969 Short tons	1969 Value (thousands)	1970 Short tons	1970 Value (thousands)	1971 Short tons	1971 Value (thousands)	1972 Short tons	1972 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.	4,462	$729	8,643	$1,015	11,425	$1,721	r 1,916	r $291	543	$107
Blooms, billets, ingots, slabs, sheet bars, and roughly forged pieces	551,708	48,201	1,810,490	142,767	3,169,563	270,368	r 873,526	r 78,191	415,392	37,860
Coils for rerolling	50,432	26,987	421,531	61,911	340,630	49,903	14,347	7,646	85,473	13,816
Blanks for tubes and pipes, iron or steel	2,095	241	12,159	1,400	2,175	280	2,334	271	2,807	311
Total	608,697	76,158	2,252,823	207,093	3,523,793	322,272	r 892,123	r 86,399	504,215	52,094
Bars, rods, angles, shapes and sections:										
Wire rods	12,317	2,316	98,245	16,348	151,062	18,541	62,843	8,415	122,894	16,169
Bars, rods, and hollow-drill steel	100,200	28,251	215,674	51,797	216,362	48,415	r 129,872	r 38,550	166,794	43,735
Concrete reinforcing bars	26,097	3,903	86,762	11,592	92,534	12,134	40,540	6,089	22,417	3,141
Angles, shapes, and sections	121,899	20,757	170,424	29,261	212,405	37,554	r 164,031	r 33,111	124,825	25,756
Plates and sheets:										
Steel plates	15,584	7,878	25,441	12,603	27,011	14,021	23,353	12,062	15,063	10,262
Steel sheets	273,043	49,486	1,040,381	146,923	1,268,386	190,079	r 583,015	r 82,982	396,860	66,679
Black plate	27,867	3,097	49,723	6,789	67,931	9,133	85,202	13,527	58,831	8,830
Iron and steel plates, n.e.c.	209,269	43,628	403,715	66,152	292,803	56,835	161,921	37,492	198,653	42,184
Tinplate and terneplate	293,265	44,550	339,606	52,264	341,275	61,844	224,120	43,101	290,255	55,272
Tinplate circles, cobbles, strip and scroll	15,267	1,405	26,080	2,577	23,910	2,628	9,716	1,186	4,565	552
Hoop and strip	56,022	26,456	111,595	38,160	376,068	73,311	129,128	42,619	404,211	76,146
Total	1,150,830	231,727	2,567,646	434,466	3,069,747	524,495	r 1,613,741	r 319,134	1,805,368	348,726
MANUFACTURED										
Rails and railway track construction materials:										
Rails	61,654	8,908	56,105	7,903	63,980	10,143	50,291	8,489	105,396	16,042
Joints and tie plates	11,052	2,149	8,323	1,585	7,976	1,620	r 8,948	2,563	9,348	2,173
Sleeper and track material of iron or steel, n.e.c.	16,820	5,603	8,708	3,507	9,873	4,104	4,599	2,073	4,767	2,231
Wire, cables, ropes, bands, and slings	63,710	28,960	82,480	37,172	72,868	38,479	62,746	38,282	69,819	43,581
Tubes, pipes, and fittings:										
Cast-iron pressure pipe and fittings	30,821	9,328	22,782	6,639	22,034	8,173	15,481	8,095	32,586	11,399
Cast-iron soil pipe and fittings	18,277	3,992	9,637	2,701	11,537	3,690	8,288	2,813	4,797	1,744
Steel tube and pipe fittings, unions, and flanges	20,044	25,953	18,344	27,397	22,262	33,214	21,707	36,679	17,517	32,001
Steel tube and pipe fittings, welded	9,878	15,185	11,641	18,708	12,840	19,469	10,546	18,306	7,155	14,082
Malleable iron tube and pipe fittings, n.e.c	1,440	1,771	2,087	2,290	1,560	1,857	2,407	2,764	2,282	2,688
Electrical conduit fittings of iron or steel	12,123	6,806	12,317	7,965	10,453	7,971	7,289	8,880	3,907	5,646
Iron tube and pipe fittings n.e.c	6,650	8,562	7,191	10,562	7,935	10,414	7,820	12,063	8,394	14,535
Seamless tubes and pipe	228,877	83,999	251,996	99,235	243,835	100,295	222,768	99,542	236,633	104,810
Welded, clinched or riveted tubes and pipe	93,738	29,122	73,767	28,992	100,721	40,579	111,564	44,709	187,548	60,504
Finished structural iron and steel	87,019	38,940	116,054	55,013	142,462	67,727	117,275	63,023	89,622	77,989
Castings and forgings	176,532	76,157	205,612	79,452	255,671	102,726	295,619	114,320	371,888	129,629

Storage tanks, lined or unlined	19,015	12,165	15,245	11,426	16,539	11,174	15,582	10,494	14,885	9,628
Nails, tacks, staples, and spikes, n.e.c	7,686	5,871	9,349	7,058	7,667	6,499	7,720	5,835	9,045	7,364
Bolts	24,230	20,327	27,753	23,829	26,069	23,634	23,837	23,348	26,062	24,962
Nuts	5,764	8,809	6,567	9,647	5,846	8,684	5,780	9,374	8,845	11,322
Screws, rivets, washers	18,417	23,445	22,003	26,546	21,271	27,622	19,939	27,342	26,401	33,270
Total	913,747	416,052	967,961	467,627	1,063,399	528,074	r 1,020,206	538,994	1,236,897	605,600
Grand total	2,673,274	723,937	5,788,430	1,109,186	7,656,939	1,374,841	r 3,526,070	r 944,527	3,546,480	1,006,420

r Revised.

Table 12.—U.S. imports for consumption of pig iron, by country

Country	1970		1971		1972	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
Australia	--	--	171	$10	--	--
Brazil	--	--	25,620	1,111	212,590	$8,044
Canada	249,129	$13,720	270,048	15,402	415,293	25,068
Germany, West	112	9	--	--	--	--
Japan	--	--	--	--	61	2
South Africa, Republic of	--	--	10,481	441	8,987	403
United Kingdom	--	--	--	--	1	1
Total	249,241	13,729	306,320	16,964	636,932	33,518

Table 13.—U.S. imports for consumption of major iron and steel products

Products	1968		1969		1970		1971		1972	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
Iron products:										
Cast iron pipes and tubes	29,010	$5,594	26,108	$5,883	18,491	$5,534	12,356	$2,516	11,870	$3,923
Malleable cast-iron fittings	10,054	3,839	8,287	3,568	9,690	4,229	11,962	6,164	13,777	7,668
Bars of wrought iron	478	173	617	153	428	123	226	65	386	120
Castings and forgings	10,117	3,572	24,311	6,283	15,819	5,446	12,975	5,219	15,395	6,447
Total	49,659	13,178	59,323	15,887	44,428	15,332	37,519	13,964	41,428	18,158
Iron and steel products:										
Ingots, blooms, billets, slabs, and sheet bars	298,678	42,359	195,176	37,514	170,647	29,917	r 274,407	37,191	261,694	38,242
Bars of steel:										
Concrete reinforcement bars	739,755	53,514	470,807	40,563	202,699	21,200	514,813	49,809	358,223	34,969
Solid and hollow steel bars	976,820	108,247	903,813	119,522	727,742	115,027	1,027,768	153,831	1,049,173	176,744
Hollow drill steel	3,708	1,351	5,412	2,036	4,212	1,687	2,392	1,088	4,606	1,285
Plates and sheets:										
Black plate	6,669	648	11,657	1,684	5,753	987	7,452	1,371	2,010	438
Steel plate	1,789,686	160,738	1,201,523	120,201	968,677	124,109	1,572,560	198,952	1,685,654	239,412
Steel sheets	r 7,324,417	r 761,250	r 4,873,519	r 557,044	r 5,271,943	r 710,623	r 7,746,573	r 1,069,372	6,959,182	1,035,327
Plates and sheets of iron or steel	229	250	809	692	250	404	417	550	532	441
Plates, sheets and strip of iron or steel [1]	10,007	2,885	30,320	6,204	50,963	10,100	75,970	14,255	64,179	13,945
Strip of iron or steel	90,961	28,873	96,162	32,921	92,335	37,934	114,902	43,678	135,400	51,850
Tinplate and terneplate	227,663	39,156	300,664	51,339	327,725	59,066	417,691	80,595	522,466	107,870
Structural iron and steel	1,559,104	157,546	1,517,373	171,669	1,300,847	186,385	1,637,154	231,060	1,745,696	247,426
Angles, shapes, and sections	668,728	56,690	522,601	48,747	416,124	50,030	550,350	61,971	562,864	65,598
Wire rods of steel	1,600,929	150,534	1,260,890	129,803	1,055,570	131,810	1,538,288	187,607	1,402,904	188,789
Sheet piling	67,545	6,654	65,957	6,854	52,335	6,189	89,208	10,605	94,781	12,909
Pipes, tubes and fittings	1,664,777	258,370	1,702,536	267,062	1,976,749	341,441	1,888,942	340,425	1,887,376	368,846
Bail ties of iron or steel	24,467	3,124	23,881	3,193	15,353	2,279	21,047	3,307	17,166	3,067
Steel castings and forgings	13,193	6,013	18,539	8,352	14,039	6,660	12,958	5,275	24,000	9,186
Rails and railway track construction materials	53,200	7,308	67,581	10,630	72,306	11,323	68,863	11,034	74,820	12,350
Wire:										
Round wire	562,740	105,985	563,265	110,097	505,164	116,561	530,194	125,722	522,205	138,618
Other wire	163,729	30,739	146,127	29,021	143,726	33,875	135,737	33,464	155,770	43,807
Nails	r 301,389	r 48,408	r 317,257	r 55,642	r 259,833	r 52,522	r 308,105	r 60,428	379,912	86,572
Total	18,148,394	2,030,642	14,295,869	1,810,790	13,634,992	2,050,129	r 18,535,791	2,721,590	17,910,613	2,877,691
Advanced manufactures:										
Bolts, nuts, rivets and washers	147,952	49,607	172,904	58,795	181,559	73,718	170,966	67,235	206,428	88,259
Grand total	18,346,005	2,093,427	14,528,096	1,885,472	13,860,979	2,139,179	r 18,744,276	2,802,789	18,158,469	2,984,108

r Revised.

[1] Includes plates, sheets and strips of iron or steel, electrolytically coated or plated; 1968: 2,591 tons ($650); 1969, 17,528 tons ($2,764); 1970, 35,610 tons ($5,802); 1971, 67,359 tons ($11,583); and 1972, 58,681 tons ($11,797).

Table 14.—Pig iron:[1] World production by country

(Thousand short tons)

Country [2]	1970	1971	1972 [p]
North America:			
Canada	9,086	8,616	[e] 9,600
Mexico [3]	2,492	2,598	2,945
United States	91,293	81,382	88,864
South America:			
Argentina	[r] 893	946	942
Brazil	[r] 4,647	5,165	5,842
Chile	530	505	536
Colombia [4]	[r] 253	268	316
Peru [4]	94	158	188
Venezuela [4]	562	568	592
Europe:			
Austria	3,267	3,141	3,137
Belgium	11,951	11,467	12,982
Bulgaria	1,325	1,472	1,672
Czechoslovakia [5]	8,320	8,775	9,182
Denmark	227	244	217
Finland	[r] 1,283	1,134	1,305
France	20,652	19,731	20,449
Germany, East [6]	2,198	2,235	2,370
Germany, West [7] [8]	[r] 36,592	32,685	35,276
Greece [9]	331	321	375
Hungary	2,008	2,172	[e] 2,271
Italy	9,184	9,410	10,378
Luxembourg	5,302	5,057	5,149
Netherlands	3,962	4,144	4,728
Norway [9]	[r] 701	682	714
Poland	7,546	7,764	[e] 8,027
Portugal	340	392	396
Romania [5]	4,641	4,830	[e] 5,300
Spain	4,591	5,321	6,528
Sweden [3]	3,079	3,040	2,792
Switzerland	31	35	30
U.S.S.R.	93,486	97,276	[e] 101,000
United Kingdom	19,297	16,823	16,715
Yugoslavia	1,405	1,669	2,006
Africa:			
Algeria [e]	77	77	77
Egypt, Arab Republic of	500	[r] [e] 550	[e] 550
Morocco	9	[e] 11	[e] 11
Rhodesia, Southern [e] [4]	[r] 300	[r] 300	300
South Africa, Republic of	[r] 4,331	4,420	4,860
Tunisia	143	108	[e] 110
Asia:			
China, People's Republic of [e] [10]	24,300	30,000	31,000
India	7,754	7,382	7,700
Iran	--	--	[e] 600
Israel [e]	40	40	40
Japan	[r] 75,011	80,187	79,427
Korea, North [e] [10]	2,600	2,800	2,900
Korea, Republic of	54	2	2
Malaysia [e]	[r] 65	[r] 75	85
Taiwan	61	84	89
Thailand	12	15	14
Turkey	1,139	972	1,245
Oceania:			
Australia	6,777	6,755	7,156
New Zealand (all sponge iron) [e]	25	[r] 110	110
Total	[r] 474,767	473,914	499,100

[e] Estimate. [p] Preliminary. [r] Revised.
[1] Table excludes all ferroalloy production except where otherwise 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: 1970—679; 1971—743; 1972—865; Sweden: 1970—204; 1971—192; 1972—196.
[4] Includes ferroalloys, if any are produced.
[5] Includes blast furnace ferroalloys.
[6] May include ferroalloys.
[7] Includes blast furnace ferroalloys except ferromanganese and speigeleisen.
[8] Revised to exclude blast furnace ferrosilicon.
[9] Includes blast furnace ferroalloys, if any are produced.
[10] Includes ferroalloy production.

Table 15.—Raw steel: [1] World production by country

(Thousand short tons)

Country [2]	1970	1971	1972 p
North America:			
Canada	12,346	12,170	13,100
Cuba	154	e 154	e 154
Mexico	4,278	4,212	4,864
United States [3]	131,514	120,443	133,241
South America:			
Argentina	2,010	2,109	2,321
Brazil [4]	r 5,942	6,626	7,185
Chile	653	720	701
Colombia	r 341	358	396
Peru	104	198	212
Uruguay	18	16	14
Venezuela	r 1,023	1,018	1,242
Europe:			
Austria	4,496	4,366	4,486
Belgium	13,897	13,717	16,019
Bulgaria	1,984	2,147	2,370
Czechoslovakia	12,655	13,304	13,988
Denmark [5]	521	519	549
Finland	1,289	1,130	1,605
France	26,205	25,197	26,515
Germany, East	5,570	5,897	6,250
Germany, West	49,649	44,439	48,177
Greece	480	525	551
Hungary	3,428	3,428	3,571
Ireland	88	88	85
Italy	19,045	19,237	21,842
Luxembourg	6,021	5,777	6,016
Netherlands	5,558	5,603	6,157
Norway	r 958	973	1,010
Poland	13,002	14,041	14,855
Portugal	424	452	452
Romania	r 7,183	7,499	8,158
Spain	8,189	8,553	10,505
Sweden	r 6,059	5,810	5,785
Switzerland	578	586	598
U.S.S.R.	r 127,742	132,979	138,891
United Kingdom	31,213	26,648	27,912
Yugoslavia	2,456	2,705	2,853
Africa:			
Algeria	39	e 40	e 40
Egypt, Arab Republic of	250	e 250	e 250
Morocco	1	e 1	e 1
Rhodesia, Southern e	165	r 176	176
South Africa, Republic of	r 5,244	5,424	5,886
Tunisia	109	95	e 100
Uganda	22	18	e 18
Asia:			
Bangladesh e	110	110	NA
Burma e	19	18	18
China, People's Republic of e	20,000	23,000	25,000
India	6,722	6,559	6,795
Israel e	130	130	130
Japan	102,869	97,617	106,814
Korea, North e	2,400	2,600	2,800
Korea, Republic of [4]	530	520	645
Lebanon e	20	20	20
Malaysia e	65	75	85
Philippines e	95	95	95
Singapore	--	136	210
Taiwan	324	432	504
Thailand	r 6	132	201
Turkey	1,446	1,237	1,590
Oceania:			
Australia	7,520	7,426	7,433
New Zealand e	75	110	110
Total	r 655,234	639,865	691,551

e Estimate. p Preliminary. r Revised. NA Not available.

[1] Steel formed in first solid state after melting suitable for further processing or sale.

[2] Pakistan was reported as a steel producing country in previous editions of this chapter, but all known crude steel production was in the former East Wing of this country, which has now become the independent nation of Bangladesh; accordingly, all output formerly credited to Pakistan is now credited to Bangladesh. 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): 1970—1,723; 1971—1,583; 1972—1,610.

[4] Ingots only.

[5] Apparently excludes shipyards' production of steel castings.

Iron and Steel Scrap

By Harold J. Polta [1]

Although domestic consumption of iron and steel scrap in the first half of the year was below that in 1971, the continued high consumption rate thereafter brought total consumption in 1972 within 1 million tons of the record high established in 1969. Exports followed a similar pattern, with monthly exports generally below those in 1971 early in the year, but with increases the latter half sufficient to make 1972 exports more than a million tons above those in 1971. The increased demand for scrap reflected the increase in steel production as the steel industry recovered from the effects of inventory building (in anticipation of a strike in the steel industry in 1971) and improved worldwide business conditions. With increased demand, scrap prices reversed their downward trend of the past several years and moved generally upward.

Interest in iron and steel scrap continued high. Spurred by environmental organizations, an increasing number of States passed legislation designed to increase recycling of junked vehicles, and a bill to encourage use of scrap was introduced in the U.S. Congress. Steel companies, can manufacturers, and scrap processors cooperated with other interested groups to operate recycling centers for the collection and disposal of tin cans. Auto manufacturers were helping communities collect and dispose of junked vehicles. A growing number of communities were reclaiming scrap from municipal refuse, and more were planning construction of facilities for this purpose. Technical foundations, consulting groups, and universities had numerous studies underway on all phases of the iron and steel scrap problems. And because it considered an international scrap shortage a real possibility within only a year or two, the International Institute of Iron and Steel established a group of experts from around the world to assess the relationship of supply and demand of scrap on the international market during the 1973–1980 period.

The Bureau of Mines agreed with the stand of the Institute of Scrap Iron and Steel that increased recycling of scrap would come only with increased demand. However, it considered technology the only ultimate answer and therefore continued researching ways to improve scrap quality and increase uses for low-quality scrap.

[1] Physical scientist, Division of Ferrous Metals—Mineral Supply.

Table 1.—Salient iron and steel scrap, and pig iron statistics in the United States

(Thousand short tons and thousand dollars)

	1971	1972
Stocks Dec. 31:		
Scrap at consumer plants	8,494	8,169
Pig iron at consumer and supplier plants	1,779	1,660
Total	10,273	9,829
Consumption:		
Scrap	r 82,567	93,371
Pig iron	81,215	89,140
Exports:		
Scrap (excludes rerolling material)	6,082	7,177
Value	206,420	233,395
Imports for consumption:		
Scrap (includes tinplate and terneplate scrap)	283	312
Value	11,259	14,741

r Revised.

Legislation and Government Programs.—H.R. 15770, "A Bill to amend the Internal Revenue Code of 1954 to provide reasonable and necessary income tax incentives to encourage the utilization of recycled solid waste materials and to offset existing income tax advantages which promote depletion of virgin natural resources," was introduced in the House of Representatives on June 29. However, while there was general unanimity on the objectives of the bill, there was considerable controversy about the specifics on how to best achieve these objectives even by the major associations of secondary metal processors. By yearend no bill with these or similar objectives had been enacted into law, but there were indications that similar legislation would receive consideration in 1973.

In January the Department of Commerce announced that exporters were no longer required to submit semimonthly reports on exports of iron and steel scrap and nickel-bearing scrap. The Department had started requiring weekly reporting in November 1970, and had amended this to semimonthly reporting in August 1971. However, near the end of the year consumers again requested export controls from the Department of Commerce because they feared the combination of increased steel production and bumper exports of scrap would cause a critical shortage of scrap. Representatives of the scrap processing industry disputed this and insisted that there was no scrap shortage. By yearend no action had been taken, but Commerce experts continued to study the situation.

Late in the year the Supreme Court agreed to review the responsibility of a Federal regulatory agency to make environmental impact assessments before approving transportation rate increases. This followed a controversy involving the railroads, scrap shippers, environmental groups, and the Interstate Commerce Commission (ICC). On October 4 the ICC entered a final order authorizing permanent rate increases, including increases on recyclable materials, which generally averaged 3%. But on November 8 the rate increases on recyclable materials was suspended until June 10, 1973, and further proceedings were opened on the environmental effects.

By October the Minnesota Pollution Control Agency (PCA) had ratified 23 contracts for the collection of an estimated 20,000 auto hulks in accordance with Minnesota's Abandoned Automobile Law, which was passed last year. The legislation provides for a $1 recycling fee on each transfer of title of a motor vehicle. Revenues collected are passed on to counties and municipalities for use in collecting abandoned and junked automobiles. Based on scrap processor prices, truckers then bid to the State for hauling the community-gathered hulks to the processor. Because the approach appeared to have the approval of all segments concerned with the junk auto problem, operation of the legislation was being watched with considerable interest.

In mid-July, Connecticut officials selected General Electric Corp. to develop and manage a Statewide system to dispose of solid wastes with maximum recovery of material and energy.[2] The recovery of 630,000 tons of ferrous and nonferrous metals could result from the plan. The State and the Federal Environmental Protection Agency provided $450,000 in contract funds for the year-long study; a project team from General Electric Corp. and the Southern Connecticut Gas Co. were to contribute an additional $665,000 in worktime.

The magnetic separation system scheduled for processing solid waste by Great Falls, Mont., starting in mid-1973 will make it the 33d community operating, or planning to operate, a magnetic reclamation system.[3] Communities included in the list were Amarillo, Tex., Atlanta, Ga., Chicago, Ill., Franklin, Ohio, Houston, Tex., Los Gatos, Calif., Madison, Wis., Martinez, Calif., Melrose Park, Ill., New Castle County, Del., Pompano Beach, Fla., St. Louis, Mo., St. Petersburg, Fla., Stickney, Ill., and Tampa, Fla.

In Wilmington, Del., a new $2 million reclamation facility, believed to be the largest in the world, was dedicated in midyear.[4] The plant, consisting princi-

---

[2] American Metal Market. Connecticut Projects Metals Recovery of 630,000 Tons Per Annum. V. 79, No. 149, Aug. 16, 1972, p. 14.

[3] American Metal Market. Great Falls, Mont., To Install Magnetic Waste Separation Unit. V. 79, No. 226, Dec. 11, 1972, p. 47.

[4] American Metal Market. Detinning May Decide Success of Recycling Plant. V. 79, No. 158, Aug. 30, 1972, p. 14.

pally of a trash shredder and magnetic separator, is hoped to obtain considerable revenue from the sale of reclaimed cans. However, there were doubts about whether the cans could be detinned and then used by the iron and steel industry economically.

The Tennessee Valley Authority (TVA) assisted valley counties in the collection of about 12,000 junked automobiles. TVA equipped seven trucks for loan to counties for junked autos. Cost of collecting was estimated to be between $6 and $8 per car. Plans were to expand the cooperative program.

In Virginia, 25 soldiers from Ft. Lee worked 6 weeks to collect about 500 of the estimated 2,000 junked vehicles in the Petersburg area. This followed a similar project in Goochland County. In both instances, police cooperated by providing escort and getting releases signed so that the vehicles could be moved.

Milwaukee was considering installation of a shredder system similar to the one in operation at Madison which recovers ferrous metals magnetically from shredded trash.

In South Dakota, Operation Pride was initiated by the Chicago and Northwestern Railway Co. to rid a 10-county area of its derelict cars through volunteer efforts.[5] Civic organizations located and made arrangements for pickup of the junked vehicles by trucks loaned by cooperating public and private organizations for delivery to collection scrap yards.

In California, the Los Angeles By-Product Co. was extracting cans magnetically from trash, cleaning and shredding the cans, and selling the shredded metal to the copper industry for use in recovering copper. The firm was processing garbage from Oakland, Piedmont, Emeryville, Albany, San Leandro, Sacramento, Walnut Creek, Concord, Lafayette, and several other Contra Costa County communities. Plans were to expand the program to other cities.[6]

The city of Palo Alto, Calif., was considering a shredding process for total recycling of garbage. The recycling center was operated at a loss of $32,000 in 1972, handling only a very small proportion of the city's total refuse, which included 75,000 vehicles.

In September the Environmental Protection Agency awarded resource recovery demonstration grants worth $20.3 million to four governmental units: Baltimore, Md., $6 million; San Diego County, Calif., $3 million; State of Delaware, $9 million; and Lowell, Mass., $2.4 million.

Processing material collected by ecology groups, municipalities, and can manufacturers, the Proler Steel Corp., Houston, Tex. sold about 200,000 tons of can scrap to the copper industry according to a spokesman for the company.[7] The firm processed the scrap for this market in its plants in El Paso, Tex., Copperton, Utah, and Chicago, Ill. The increase in the use of cans for precipitating copper in recent years, estimated at 600,000 tons in 1972, has encouraged environmentalists to view the copper industry as a major market for reclaimed cans. However, the two largest precipitated copper processors, Kennecott Copper Corp. and The Anaconda Company, see only a gradual expansion of the process over the next few years, according to spokesmen for the companies.

AVAILABLE SUPPLY

The new supply of iron and steel scrap available for consumption at consumer's plants in 1972 was 92.9 million short tons. It consisted of 51.2 million tons of home scrap, and 40.3 million tons of purchased scrap (net receipts). Compared with 1971 figures, home scrap production was up 4.1% and net receipts were up 18.6%.

CONSUMPTION

Consumers reported consumption of 93.4 million tons of iron and steel scrap in 1972. This was a 13% increase over consumption of the year before, and only 1.5% below the record high established in 1969. Consumption consisted of 51.2 mil-

[5] Readers Digest. Get Those Junked Cars Off the Landscape. V. 101, No. 605, September 1972, pp. 88–92.

[6] American Metal Market. Profitable Can Salvage Program Operated by Los Angeles Firm. V. 79, No. 22, Feb. 2, 1972, p. 10.

[7] American Metal Market. Use of Steel Scrap to Produce Copper from Copper Ore Jumps. V. 79, No. 237, Dec. 27, 1972, pp. 14–15.

lion tons of home scrap (assuming reported scrap production equals consumption of home scrap), and 42.2 million tons of purchased scrap (assuming consumption of purchased scrap equals total scrap consumption minus scrap production).

STOCKS

The stockpile of 8.2 million tons of iron and steel scrap reported on hand at consumers' plants on December 31, 1972, was 4% below that reported on hand the previous yearend. During the first half of the year the end-of-month stocks remained between 8.2 and 8.4 million tons; then they rose rapidly to a high of nearly 8.8 million tons in August. Thereafter they declined, so that by yearend they were 325,000 tons below those reported at the end of 1971.

PRICES

Prices of iron and steel scrap rose sharply at the beginning of 1972, then leveled off, but started to rise again in late July. Thereafter prices continued to rise so that by yearend the Iron Age No. 1 heavy melting price of $46.17 equaled the monthly average peak established in February 1970. The December average No. 1 heavy melting price of $43.16 was 44% above the December average in 1971. It was the highest monthly average price since 1960 with the exception of February and March 1970 when the monthly average for No. 1 heavy melting was $46.17 and $43.83, respectively.

FOREIGN TRADE

Exports of iron and steel scrap were below those in 1971 the first half of the year, but the continued high export rate thereafter made total exports for the year well above those of the year before. The 1972 total, 7.2 million short tons (excluding rerolling material, and ships, boats, and other vessels for scrapping), was 18% above that exported in 1971, but 29% below the record high exports of 1970. Japan again was the largest importer of U.S. scrap, taking 32% of total exports. Next largest importer of U.S. scrap was Canada, which took 13%. Spain and Italy each received 10% of U.S. scrap exports.

No. 1 heavy melting continued as the largest export grade, accounting for 32% of the total. Next largest export grades were shredded and No. 2 bundles, which accounted for 20% and 12%, respectively.

WORLD REVIEW

Exports of iron and steel scrap from the United Kingdom approached 772,000 short tons in the first half of 1972. This was made possible because of relaxation of restrictions on most grades of scrap in 1971 and because of decreased domestic demand resulting from the recession in the steel industry. With improvements in the British steel industry, domestic demand for scrap rose and export restrictions on the better grades of scrap were to be reimposed by the Department of Trade and Industry on September 11. However, the reimposition of controls was delayed until the end of October because of a prolonged dock strike.

At the same time, discussions were being held between the British Scrap Federation, the British Steel Corp. (BSC), and the British Independent Steel Producers Association concerning future arrangements with the scrap industry when the United Kingdom would become a member of the European Community (EC). Although the United Kingdom was scheduled to become part of the EC on January 1, 1973, it had secured agreement in its negotiations with the EC for a transitional period of up to 2 years during which restrictions on the British industry could remain. Since the 1930's BSC and the scrap merchants had operated under an agreement which guaranteed negotiated prices, provided for a scrap grading system, and gave preference to scrap arising in the United Kingdom. After the transitional period the United Kingdom would have to abide by EC rules. These rules would make export controls on scrap by the United Kingdom no longer permissible. After successful negotiation for the 2-year transition period in response to requests from the British steel industry, the industry at the turn of the year surprisingly announced that the long standing scrap merchant-steel industry agreement would be terminated in July 1973.

In addition to the concerns about how entry into the EC would affect the United Kingdom steel and scrap industries, the British shared the concern with other countries of possible scrap shortages in the years ahead. With one private sector mini steel mill already operating and several more being planned including, possibly, similar installations by BSC, the demand for scrap was expected to grow significantly. The virtual ban on overseas sales of scrap scheduled to begin February 1, 1973, and the start of negotiations for imports from the Soviet Union were signs of the growing concern about the ability of the British scrap merchants to supply the needs of the British steel industry.

According to an official in its Steel Division, the EC established an overall export

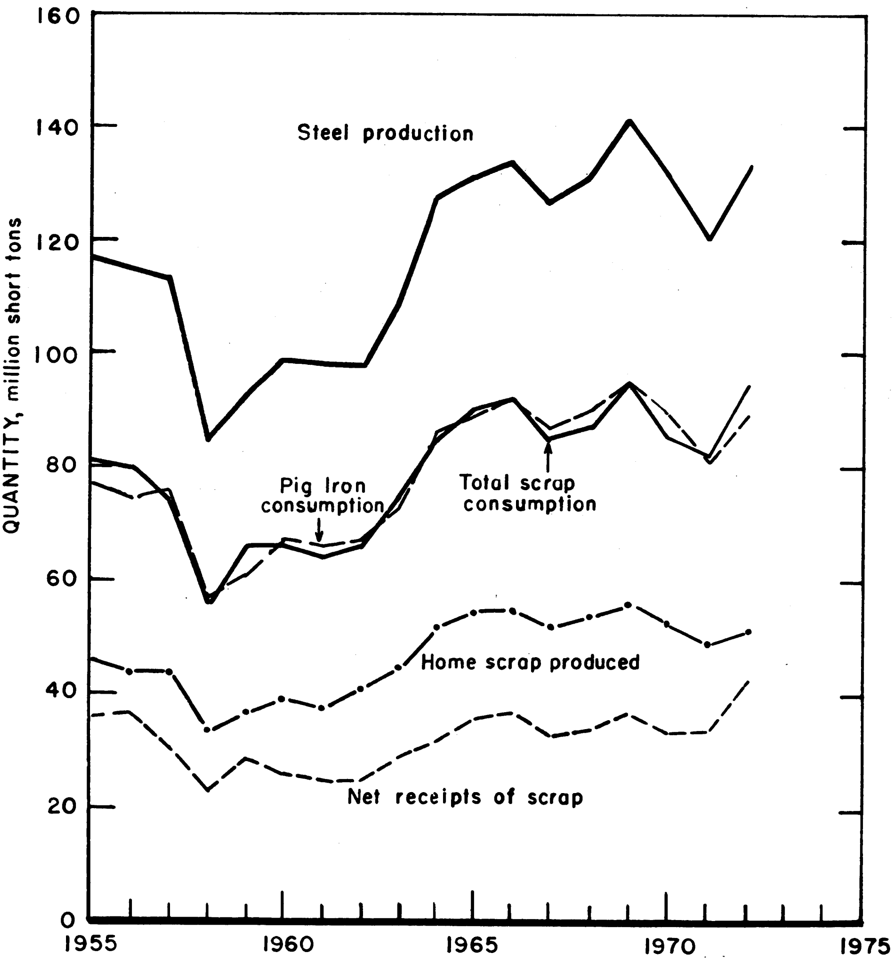

Figure 1.—Steel production (AISI); total iron and steel scrap consumption; pig iron consumption; home scrap production; and net scrap receipt.

ceiling of 178,000 tons for the first half of 1973. The decision guaranteed an export quota of 55,000 tons to West Germany, 80,000 tons to France, and 33,000 tons to the Netherlands. However, the decision could be reexamined at any time and had to be reexamined before March 31, 1973.

In France, regrouping of the ferrous scrap processing industry through mergers and takeovers left the country with only four major scrap processors.[8] The regroupment was reported to have given financing ability for branching out into such ventures as mini-steel mills, four of which were cited as being in the planning stage. Steady, but low demand for scrap throughout the year had the price of No. 1 scrap as low as $20 a ton. However, demand increased sharply in November so that the price rose to $30 by the end of the year. French scrap processors are subject to EC Commission rules and apparently are somewhat frustrated by export controls to third countries.

Luxembourg reported consumption of 1.6 million tons of iron and steel scrap in 1972. Most of this came from domestic sources. Imports, principally from its EC partners, supplied only 321,000 tons. Luxembourg does not export any scrap, and there are no special price controls in effect.

TECHNOLOGY

Processors of scrap continued to upgrade scrap, particularly through the use of shredders. The 100 or so shredders built in the past 10 years have an annual shredding capacity of about 4 million tons. The use of auto flatteners has greatly increased the number of junked autos that can be hauled on a vehicle and has extended the economic haul distance for junked autos considerably.

With most areas in the country, where huge generations of scrap exist, already having very large shredding plants capable of shredding 10,000 to 18,000 tons a month, the trend was towards the design and marketing of smaller less expensive shredding facilities. At the Third Mineral Waste Utilization Symposium in March,[9] a participant stated that the country could support an additional 100 shredding plants having a 3,000-to 4,000-ton-per-month capacity. According to calculations presented, capital investment of about $750,000 was required for such an installation. The "Auto Reduction Mill" designed and installed in St. Paul by Dravo Corp. was the first shredder type machine with hammers rotating about a vertical axis.[10] Chief advantage of the 30-ton-per-hour capacity mill, according to the corporation, was its ability to produce a denser product than the conventional hammermill-type shredder. In Wisconsin the Appleton Machine Co. was building a preshredder for the Ripsteel Corp.[11] The machine was designed to tear automobiles into small pieces that could be either baled or fed continuously into a small high-speed hammermill.

Early in the year National Steel Corp. demonstrated to an audience of public officials, food and beverage packers, can manufacturers, and conservationists that it is technically feasible to use scrap steel cans in steelmaking by including 8 tons of cans to an electric furnace heat and 37.5 tons of scrap to the charge of a blast furnace at the rate of 50 pounds per ton of hot metal produced.[12]

Following an American Iron and Steel Institute contract with Swindell-Dressler Corp. for evaluating various techniques for separating ferrous materials (including cans) from municipal wastes deposited at transfer stations prior to their incineration or burial in land fills, National Steel Corp. joined Stroh Brewery Co. in commissioning Swindell-Dressler to make a follow-up study, namely, the reclamation and remelting of incinerated scrap steel cans into new primary steel.

---

[8] American Metal Market. France Optimistic on New Year, But Not Ready to Go Overboard. V. 80, No. 9, Jan. 12, 1973, p. 11A.

[9] U.S. Bureau of Mines and IIT Research Institute. Proc. 3d Mineral Waste Utilization Symp. Mar. 14–16, 1972, Chicago, Ill., 1972, pp. 224–233.

[10] American Metal Market. Dravo Sells 1st 'Auto Reduction Mill' to Alter; Operation Set for Early January. V. 79, No. 204, Nov. 8, 1972, p. 20.

[11] American Metal Market. Firms Join in Producing Car Shredder. V. 79, No. 18, Jan. 26, 1972, p. 14.

[12] American Metal Market. New Mill Capabilities Shown in Steel Can Recycling. V. 79, No. 12, Jan. 18, 1972, p. 17.

Full-scale tests at Bethlehem Steel Corp.'s Homer Research Laboratories demonstrated the technical feasibility of high-temperature scrap preheating according to an engineer of the corporation.[13] Economic advantages in each case, however, would have to be weighed against local conditions ranging from characteristics of available scrap, cost, and availability of electric power, and the need for additional productivity. According to the company, favorable scrap characteristics and a satisfactory bucket height-to-diameter ratio would make it possible to preheat scrap to an average temperature of 1,350°F, and thus to realize a 20% increase in productivity and a 20% lower power consumption.

Avco Systems Div. Avco Corp., of Lowell, Mass., was building a prototype model of a ferromagnetic fluid system for separating mixed nonferrous metals.[14] One of the major applications would be the processing of fragmentized auto scrap after the ferrous materials had been removed by magnetic separation.

Whirlpool Corp. was conducting a pilot test program to study various ways of processing wornout appliances for usable steel in a separation and compaction process.[15] The processed appliances were then shipped to Inland Steel Corp. for test melts to determine what steelmaking problems would be encountered.

General Motors Corp. reportedly was hoping to increase internal scrap consumption through several innovative processes.[16] With its "XtrueCast" process the corporation was hoping to convert sheet metal offal, turnings, bar ends, and forging flash into bar stock. With another technique it was using waste material, and turning it into "Macro Mesh," a coarse metal powder suitable for making metal parts such as pole shoes for automobile starter motors. This process involves vapor degreasing to remove cutting oil, separation of trash, shredding, and screening.

The Bureau of Mines continued to direct considerable attention to finding ways to improve scrap quality and/or ways to use lower quality scrap. At its metallurgy research center in College Park, Md., the Bureau was studying ways to improve and optimize its pilot plant for processing municipal incinerator residue. Much of the crude incinerator residue fed to the plant was from municipalities that were under consideration for funding of demonstration plants of similar design by the Environmental Protection Agency. The iron and steel, copper, and other scrap concentrate fractions from the plant were made available to Bureau and industry metallurgists for other research projects. At College Park these included producing and evaluating products made from melts of incinerated can scrap, and removing copper from molten ferrous scrap. Plans were to also study raw municipal refuse and a laboratory scale plant was being assembled for this purpose. Objectives were to gather data on composition, particularly percentages of individual metals and alloys; separate scrap metals and other potentially valuable components from the refuse; make cost analyses of the process; and provide concentrate samples for utilization research.

At the Bureau's Twin Cities Research Center in Minnesota, metallurgists were investigating the effects of impurities in incinerator residue scrap on the properties of synthetic foundry pig and gray iron. Plans were to similarly investigate effects of impurities on metal products made from shredded automobile scrap and machine-shop chips and turnings. Other research hoped to develop a process to remove copper from aggregates of copper, glass, iron, and organic resins or fibers using an electrochemical salt cell. Another project had as its objective the removal of nonferrous contaminants from iron oxide products through use of a pelletization-chlorinization process. The hypothesis that removing seats from cars before shredding reduces copper content was also being investigated.

Metallurgists at the Bureau's Albany, Oreg. Research Center were developing electric steelmaking practices for utilizing the ferrous fraction of urban waste in the production of carbon and low-alloy steels. They were investigating the nature of the scrap recovered from urban waste, how the material relates to scrap specifications used

[13] American Metal Market. Bethlehem Tests Support Scrap Preheating Process. V. 79, No. 236, Dec. 26, 1972, p. 17.

[14] American Metal Market. Avco Developing System to Separate Nonferrous. V. 79, No. 186, Oct. 11, 1972, pp. 12, 13.

[15] American Metal Market. Home Appliance Salvage is Studied by Whirlpool. V. 79, No. 172, Sept. 20, 1972, p. 23.

[16] Industry Week. GM turning scrap into metal powder. V. 173, No. 2, Apr. 10, 1972, p. 24.

by steelmakers, and procedures that could lead to efficient use of processed scrap.

At Salt Lake City, Utah, Bureau researchers were concluding studies on the processing of shredded municipal refuse through horizontal and vertical air classification, and were gathering data to make a cost analysis of the process. They were also continuing studies directed towards increasing recycling of obsolete automobiles, and other vehicles. These included studying the economics of incinerating auto hulks prior to shredding; testing the nonferrous metal concentrate to determine the most efficient and economic method to separate aluminum, copper, and zinc die castings; and developing continuous cryogenic systems for reclaiming copper from insulated wires, crushing tires, and recovering iron and copper from small motors and generators.

At Rolla, Mo., Bureau metallurgists were investigating the effects of copper and tin, singly and in combination, and other impurities on properties of ductile iron castings. This research supplemented, and was coordinated with, past and ongoing Bureau sponsored research at the University of Wisconsin. Because copper and tin are so difficult to remove when alloyed with iron and steel, these studies were investigating and trying to determine precisely how copper and tin affect the properties of ferrous metals containing these elements.

A complete list of Bureau of Mines scrap-related research efforts is contained in an information circular on the subject.[17]

[17] Kenahan, C. B., R. S. Kaplan, J. T. Dunham, and D. G. Linnehan. Bureau of Mines Research Programs on Recycling and Disposal of Mineral-, Metal-, and Energy-Based Wastes. BuMines IC 8595, 1973, 54 pp.

Table 2.—Consumers stocks, receipts, production, consumption, and shipments of iron and steel scrap in 1972, by grade

(Thousand short tons)

Grades of scrap	Receipts	Production	Consumption	Shipments	Stocks Dec. 31
MANUFACTURERS OF STEEL INGOTS AND CASTINGS					
Carbon steel:					
Low-phosphorous plate and punchings	523	12	538	4	55
Cut structural and plate	526	--	525	1	50
No. 1 heavy melting steel	9,018	20,303	27,751	1,913	2,599
No. 2 heavy melting steel	2,299	1,088	3,362	92	329
No. 1 and electric furnace bundles	6,126	730	6,746	87	860
No. 2 and all other bundles	2,611	524	2,997	126	352
Turnings and borings	1,570	331	1,753	157	178
Slag scrap (Fe content)	1,404	1,767	3,076	119	86
Shredded or fragmentized	1,508	--	1,507	1	72
All other carbon steel scrap	3,718	12,609	15,058	1,188	1,066
Stainless steel	413	575	930	50	99
Alloy steel (except stainless)	413	2,032	2,457	67	242
Cast iron (includes borings)	2,391	4,125	5,234	1,311	1,055
Other grades of scrap	1,182	335	1,481	44	23
U.S. total	33,702	44,431	73,415	5,160	7,066
Pig iron	4,136	88,941	86,207	6,715	1,377
MANUFACTURERS OF STEEL CASTINGS					
Carbon steel:					
Low-phosphorous plate and punchings	528	156	687	4	59
Cut structural and plate	171	4	178	--	8
No. 1 heavy melting steel	127	71	203	1	20
No. 2 heavy melting steel	1	--	1	--	--
No. 1 and electric furnace bundles	101	--	107	--	8
No. 2 and all other bundles	15	--	15	--	--
Turnings and borings	66	8	70	4	6
Slag scrap (Fe content)	1	4	6	--	--
Shredded or fragmentized	51	--	53	--	3
All other carbon steel scrap	518	282	797	5	67
Stainless steel	15	14	26	2	8
Alloy steel (except stainless)	68	70	127	14	20
Cast iron (includes borings)	171	118	295	3	38
Other grades of scrap	44	56	99	4	6
U.S. total	1,877	783	2,664	37	243
Pig iron	59	--	60	1	6

Table 2.—Consumers stocks, receipts, production, consumption, and shipments of iron and steel scrap in 1972, by grade—Continued

(Thousand short tons)

Grades of scrap	Receipts	Production	Consumption	Shipments	Stocks Dec. 31
IRON FOUNDRIES AND MISCELLANEOUS USERS					
Carbon steel:					
Low-phosphorous plate and punchings	1,009	53	1,046	10	54
Cut structural and plate	963	92	1,038	7	62
No. 1 heavy melting steel	311	76	377	27	12
No. 2 heavy melting steel	36	24	59	2	3
No. 1 and electric furnace bundles	371	--	368	--	17
No. 2 and all other bundles	633	10	671	1	41
Turnings and borings	608	47	617	42	56
Slag scrap (Fe content)	9	8	17	--	--
Shredded or fragmentized	506	--	502	1	25
All other carbon steel scrap	2,079	132	2,103	24	224
Stainless steel	10	--	13	--	3
Alloy steel (except stainless)	127	9	144	1	18
Cast iron (includes borings)	4,448	5,137	9,545	119	320
Other grades of scrap	431	382	791	19	25
U.S. total [1]	11,541	5,970	17,292	253	860
Pig iron	3,010	--	2,873	147	277
TOTAL—ALL TYPES OF MANUFACTURERS					
Carbon steel:					
Low-phosphorous plate and punchings	2,060	220	2,271	18	168
Cut structural and plate	1,660	95	1,740	7	120
No. 1 heavy melting steel	9,456	20,450	28,331	1,941	2,631
No. 2 heavy melting steel	2,336	1,112	3,422	94	331
No. 1 and electric furnace bundles	6,599	731	7,221	87	884
No. 2 and all other bundles	3,260	534	3,683	127	394
Turnings and borings	2,244	385	2,440	204	241
Slag scrap (Fe content)	1,414	1,780	3,099	119	87
Shredded or fragmentized	2,064	--	2,062	2	100
All other carbon steel scrap	6,315	13,024	17,959	1,217	1,357
Stainless steel	438	589	969	52	109
Alloy steel (except stainless)	608	2,112	2,728	82	280
Cast iron (includes borings)	7,010	9,379	15,074	1,433	1,412
Other grades of scrap	1,657	773	2,372	67	55
U.S. total [1]	47,120	51,184	93,371	5,450	8,169
Pig iron [2]	7,205	88,941	89,140	6,863	1,660

[1] Data may not add to totals shown because of independent rounding.
[2] Includes all pig iron used in reporting establishments.

Table 3.—Consumption of iron and steel scrap and pig iron [1] in the United States in 1972, by type of consumer and type of furnace or equipment

(Thousand short tons)

Type of furnace or equipment	Manufacturers of steel ingots and castings [2]		Manufacturers of steel castings [3]		Iron foundries and miscellaneous users		Total all types	
	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron
Blast furnace [4]	3,565	--	--	--	--	--	3,565	--
Basic oxygen converter [5]	24,192	60,233	--	--	--	--	24,192	60,233
Open-hearth furnace	18,638	22,361	187	14	--	--	18,825	22,375
Electric furnace	24,886	777	2,165	34	3,408	150	30,459	961
Cupola furnace	1,759	330	278	5	13,507	1,929	15,544	2,264
Air furnace	32	84	33	7	121	48	186	139
Other furnaces [6]	343	247	1	--	256	7	600	254
U.S. total	73,415	84,032	2,664	60	17,292	2,134	93,371	[7] 86,226

[1] Excludes molten pig iron used for ingot molds and direct castings.
[2] Includes only those manufacturers of steel castings that also produce ingots.
[3] Excludes companies that produce both steel ingots and steel castings.
[4] Includes consumption in all blast furnaces producing pig iron.
[5] Includes scrap and pig iron processed in metallurgial blast cupolas and used in oxygen converters.
[6] Includes vacuum melting furnaces and miscellaneous melting processes.
[7] Excludes pig iron used in making molds and poured directly into castings.

Table 4.—Proportion of iron and steel scrap and pig iron used in furnaces in the United States

(Percent)

Type of furnace	1972	
	Scrap	Pig iron
Basic oxygen converter	28.7	71.3
Open-hearth furnace	45.7	54.3
Electric furnace	96.9	3.1
Cupola furnace	87.3	12.7
Air furnace	57.2	42.8

Table 5.—Iron and steel scrap supply [1] available for consumption in 1972, by State and region

(Thousand short tons)

State and region	Receipts	Production	Total new supply	Shipments [2]	New supply available for consumption
New England: Connecticut, Maine, New Hampshire, Massachusetts, Rhode Island, and Vermont	228	145	373	12	361
Total	228	145	373	12	361
Middle Atlantic:					
New Jersey	505	137	642	8	634
New York	1,129	1,556	2,685	220	2,465
Pennsylvania	7,585	11,462	19,047	1,812	17,235
Total	9,219	13,155	22,374	2,040	20,334
East North Central:					
Illinois	5,598	4,203	9,801	414	9,387
Indiana	2,855	8,754	11,609	660	10,949
Michigan	5,658	4,347	10,005	189	9,816
Ohio	7,930	9,058	16,988	1,424	15,564
Wisconsin	527	398	925	21	904
Total	22,568	26,760	49,328	2,708	46,620
West North Central: Iowa, Minnesota, Missouri, Nebraska, and Kansas	1,918	634	2,552	116	2,436
Total	1,918	634	2,552	116	2,436
South Atlantic:					
Delaware, Maryland, and West Virginia	1,566	3,139	4,705	81	4,624
Florida and Georgia	682	136	818	2	816
North Carolina, South Carolina, and Virginia	1,193	279	1,472	12	1,460
Total	3,441	3,554	6,995	95	6,900
East South Central:					
Alabama	1,753	2,009	3,762	69	3,693
Kentucky and Mississippi	928	930	1,858	163	1,695
Tennessee	780	265	1,045	12	1,033
Total	3,461	3,204	6,665	244	6,421
West South Central: Arkansas, Louisiana, Oklahoma, and Texas	2,723	1,368	4,091	88	4,003
Total	2,723	1,368	4,091	88	4,003
Mountain and Pacific: Arizona, Colorado, Montana, Nevada, Utah, California, Washington, and Oregon	3,562	2,364	5,926	147	5,779
Total	3,562	2,364	5,926	147	5,779
U.S. total	47,120	51,184	98,304	5,450	92,854

[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] Includes scrap shipped, transferred, or otherwise disposed of during the year.

Table 6.—Consumption of iron and steel scrap and pig iron [1] by State and region, by type of manufacturers in 1972

(Thousand short tons)

State and region	Steel ingots and castings [2]		Steel castings [3]		Iron foundries and miscellaneous users		Total	
	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron
New England:								
Connecticut	63	--	--	--	50	14	113	14
Maine, New Hampshire, Massachusetts, and Rhode Island	88	--	14	--	132	28	234	28
Vermont	--	--	--	--	8	3	8	3
Total	151	--	14	--	190	45	355	45
Middle Atlantic:								
New Jersey	216	--	26	--	409	58	651	58
New York	1,553	3,605	129	3	770	52	2,452	3,660
Pennsylvania	16,570	20,748	326	26	689	99	17,585	20,873
Total	18,339	24,353	481	29	1,868	209	20,688	24,591
East North Central:								
Illinois	7,577	6,796	391	3	1,434	310	9,402	7,109
Indiana	9,750	14,943	156	2	823	173	10,729	15,118
Michigan	5,255	6,957	130	1	4,434	569	9,819	7,527
Ohio	12,923	15,520	303	13	2,368	575	15,594	16,108
Wisconsin	--	--	227	3	679	116	906	119
Total	35,505	44,216	1,207	22	9,738	1,743	46,450	45,981
West North Central: Iowa, Minnesota, Missouri, Nebraska, and Kansas	1,308	--	278	2	870	84	2,456	86
Total	1,308	--	278	2	870	84	2,456	86
South Atlantic:								
Delaware, Maryland, and West Virginia	4,456	6,972	69	1	101	27	4,626	7,000
Florida and Georgia	795	--	4	--	32	9	831	9
North Carolina, South Carolina, and Virginia	855	--	11	--	596	142	1,462	142
Total	6,106	6,972	84	1	729	178	6,919	7,151
East South Central:								
Alabama	2,265	3,248	202	--	1,352	380	3,819	3,628
Kentucky and Mississippi	1,377	1,696	--	--	302	33	1,679	1,729
Tennessee	286	--	18	1	698	84	1,002	85
Total	3,928	4,944	220	1	2,352	497	6,500	5,442
West South Central: Arkansas, Louisiana, Oklahoma, and Texas	3,325	1,129	77	--	692	25	4,094	1,154
Total	3,325	1,129	77	--	692	25	4,094	1,154
Mountain and Pacific: Arizona, Colorado, Montana, Nevada, Utah, California, Washington, and Oregon	4,753	4,593	303	5	853	92	5,909	4,690
Total	4,753	4,593	303	5	853	92	5,909	4,690
U.S. total	73,415	86,207	2,664	60	17,292	2,873	93,371	89,140

[1] Includes molten pig iron used for ingot molds and direct castings.
[2] Includes only those manufacturers of steel castings that also produce ingots.
[3] Excludes companies that produce both steel ingots and castings.

Table 7.—Consumer stocks of iron and steel scrap, by grade, and pig iron, Dec. 31, 1972, 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	Pig iron stocks
New England:							
Connecticut, Maine, and New Hampshire	3	3	1	5	--	12	2
Massachusetts	2	--	--	2	--	4	2
Rhode Island and Vermont	9	--	1	2	--	12	1
Total	14	3	2	9	--	28	5
Middle Atlantic:							
New Jersey	26	--	1	11	--	38	10
New York	231	8	13	119	--	371	241
Pennsylvania	1,070	47	139	247	7	1,510	241
Total	1,327	55	153	377	7	1,919	492
East North Central:							
Illinois	864	3	23	42	1	933	80
Indiana	1,016	8	14	383	3	1,424	28
Michigan	348	10	1	93	3	455	146
Ohio	1,126	13	39	215	2	1,395	396
Wisconsin	20	--	--	9	1	30	5
Total	3,374	34	77	742	10	4,237	655
West North Central:							
Iowa	32	--	--	8	2	42	15
Minnesota and Missouri	258	--	1	14	2	275	9
Nebraska and Kansas	5	--	--	1	--	6	--
Total	295	--	1	23	4	323	24
South Atlantic:							
Delaware, Maryland, and West Virginia	162	9	10	41	--	222	10
Florida and Georgia	76	--	--	1	--	77	2
North Carolina and South Carolina	12	--	--	7	--	19	3
Virginia	9	--	--	17	--	26	10
Total	259	9	10	66	--	344	25
East South Central:							
Alabama	198	2	--	50	--	250	298
Kentucky and Mississippi	128	--	18	11	12	169	30
Tennessee	36	--	--	18	1	55	6
Total	362	2	18	79	13	474	334
West South Central: Arkansas, Louisiana, Oklahoma, and Texas	185	--	13	21	2	221	65
Total	185	--	13	21	2	221	65
Mountain: Arizona, Colorado, Montana, Nevada, and Utah	167	--	1	6	16	190	32
Total	167	--	1	6	16	190	32
Pacific:							
California	237	--	2	81	3	323	27
Washington and Oregon	93	6	3	8	--	110	1
Total	330	6	5	89	3	433	28
U.S. total	6,313	109	280	1,412	55	8,169	1,660

Table 8.—Average monthly price and composite price for No. 1 heavy melting scrap in 1972

(Per long ton)

Month	Chicago	Pittsburgh	Philadelphia	Composite price [1]
January	$32.10	$36.30	$32.10	$33.50
February	34.87	37.25	34.50	35.54
March	35.00	35.50	34.75	35.08
April	34.75	35.50	35.50	35.25
May	34.40	36.50	35.60	35.50
June	34.75	36.00	35.00	35.25
July	36.10	37.50	34.50	36.03
August	37.50	40.50	34.75	37.58
September	37.50	39.50	38.00	38.33
October	37.50	38.70	38.50	38.23
November	37.75	40.50	39.50	39.25
December	42.50	43.75	43.25	43.16
Average:				
1972	36.22	38.12	36.33	36.89
1971	33.40	36.15	32.71	34.09

[1] Composite price, Chicago, Pittsburgh, Philadelphia.

Source: Iron Age, Jan. 4, 1973.

Table 9.—U.S. exports and imports for consumption of iron and steel scrap, by class

(Thousand short tons and thousand dollars)

Class	1968		1969		1970		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Exports:										
No. 1 heavy melting scrap	2,482	72,286	3,452	114,646	3,654	158,483	1,827	64,514	2,289	79,246
No. 2 heavy melting scrap	783	20,384	1,009	29,760	1,140	45,516	645	20,297	756	23,200
No. 1 baled steel scrap	269	7,151	593	19,679	377	16,290	233	8,460	180	6,112
No. 2 baled steel scrap	969	18,999	1,038	22,038	1,381	41,902	987	22,519	897	19,623
Stainless steel scrap	113	26,305	76	22,868	87	30,926	44	12,518	48	11,679
Shredded steel scrap [1]	--	--	--	--	1,165	49,344	1,026	36,568	1,463	48,186
Borings, shovelings, and turnings	439	8,359	767	13,135	619	15,311	390	8,663	508	10,761
Other steel scrap [2]	973	30,548	1,361	46,930	881	44,423	465	19,030	597	21,562
Iron scrap	416	10,868	627	20,481	807	29,715	465	13,851	439	13,026
Total	6,444	194,900	8,923	289,537	10,111	431,910	6,082	206,420	7,177	233,395
Ships, boats and other vessels (for scrapping)	120	2,105	114	2,319	531	11,474	396	6,824	299	9,009
Total	6,564	197,005	9,037	291,856	10,642	443,384	6,478	213,244	7,476	242,404
Rerolling material	127	5,844	254	13,170	251	15,464	175	8,978	207	10,213
Grand total	6,691	202,849	9,291	305,026	10,893	458,848	6,653	222,222	7,683	252,617
Imports:										
Iron and steel scrap	276	10,784	311	12,571	279	10,609	263	10,713	295	14,304
Tinplate scrap	18	541	24	917	22	591	20	546	17	437
Total	294	11,325	335	13,488	301	11,200	283	11,259	312	14,741

[1] Separately classified Jan. 1, 1970, formerly part of other steel scrap.
[2] Includes terneplate and tinplate.

Table 10.—U.S. exports of iron and steel scrap, by country

(Thousand short tons and thousand dollars)

Country	1968		1969		1970		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Argentina	(1)	21	(1)	3	6	370	63	1,757	231	7,857
Belgium-Luxembourg	21	769	33	1,844	21	3,563	8	947	5	300
Brazil	(1)	6	(1)	6	--	--	1	15	61	2,174
Canada	516	12,009	616	15,286	707	21,525	887	26,204	903	26,605
Egypt	30	668	27	689	(1)	463	--	--	--	--
France	15	1,633	47	2,868	57	2,785	8	298	(1)	5
Germany, West	58	2,952	93	5,345	45	2,069	13	1,152	7	473
Greece	9	194	--	--	--	--	37	1,228	163	4,893
Hong Kong	(1)	272	1	181	6	652	26	1,023	1	277
Italy	729	20,364	879	25,781	491	22,657	590	22,599	717	23,222
Japan	3,383	92,098	4,204	126,254	5,208	208,601	1,744	54,369	2,309	71,309
Korea, Republic of	304	10,004	553	20,347	667	30,971	324	11,799	380	13,086
Mexico	525	18,074	580	20,210	821	35,368	555	20,027	587	22,301
New Zealand	--	--	--	--	7	338	--	--	19	535
Pakistan	22	457	(1)	40	(1)	11	52	1,639	(2) 21	(2) 766
Singapore	--	--	--	--	--	--	--	--	25	971
Spain	306	6,939	1,034	29,052	1,154	45,725	610	20,354	721	21,452
Sweden	105	16,068	204	19,766	161	24,712	20	4,437	21	4,545
Taiwan	157	4,604	95	3,658	151	7,097	387	12,584	419	14,028
Thailand	47	1,323	61	1,950	45	1,950	39	1,464	85	2,945
Turkey	77	1,940	79	2,013	72	3,530	73	2,465	125	4,571
United Kingdom	3	268	310	10,514	251	10,909	335	12,785	25	1,029
Venezuela	30	783	58	1,683	179	5,587	212	5,244	284	7,734
Yugoslavia	65	1,876	11	450	22	1,006	56	2,271	--	--
Other	42	1,578	38	1,597	40	2,021	42	1,759	68	2,317
Total	6,444	194,900	8,923	289,537	10,111	431,910	6,082	206,420	7,177	233,395

[1] Less than ½ unit.
[2] Includes Bangladesh, 14,781 short tons ($521,810).

Table 11.—U.S. exports of rerolling material (scrap), by country

(Thousand short tons and thousand dollars)

Country	1968		1969		1970		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Canada	(1)	28	(1)	8	5	208	1	46	2	118
Japan	10	343	15	588	13	584	5	190	17	789
Korea, Republic of	101	4,728	174	8,318	187	11,737	83	4,562	73	3,491
Mexico	9	447	22	1,103	33	2,036	27	1,530	35	1,883
Pakistan	--	--	--	--	--	--	--	--	24	1,047
Spain	--	--	--	--	--	--	1	59	5	319
Taiwan	7	298	3	156	(1)	10	44	2,023	20	951
Thailand	--	--	12	707	6	398	--	--	15	654
Turkey	--	--	--	--	--	--	--	--	9	533
Venezuela	--	--	2	65	2	99	2	105	3	200
Yugoslavia	--	--	--	--	--	--	11	419	--	--
Other	--	--	26	2,225	5	392	1	44	4	228
Total	127	5,844	254	13,170	251	15,464	175	8,978	207	10,213

[1] Less than ½ unit.

Table 12.—U.S. exports of ships, boats, and other vessels for scrapping

(Thousand short tons and thousand dollars)

Country	1968		1969		1970		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Bahamas	8	137	5	78	--	--	--	--	--	--
Canada	7	97	3	20	18	338	30	493	36	583
Germany, West	--	--	--	--	15	197	5	77	--	--
Hong Kong	8	275	12	210	--	--	--	--	--	--
Italy	--	--	--	--	48	913	--	--	--	--
Japan	3	125	--	--	6	100	--	--	5	74
Mexico	--	--	3	51	--	--	--	--	--	--
Netherlands	--	--	--	--	15	275	--	--	--	--
Spain	51	725	70	1,098	357	7,637	255	4,788	146	3,907
Taiwan	38	734	20	849	58	1,607	106	1,463	112	4,445
Other	5	12	1	13	14	407	(1)	3	--	--
Total	120	2,105	114	2,319	531	11,474	396	6,824	299	9,009

[1] Less than ½ unit.

Table 13.—U.S. imports for consumption of iron and steel scrap, by country

Country	1971		1972	
	Short tons	Value (thousands)	Short tons	Value (thousands)
Australia	10	$3	18	$8
Canada	261,093	10,038	288,509	12,308
French West Indies	--	--	1,296	43
Germany, West	86	1	1,611	278
Jamaica	--	--	1,009	33
Japan	--	--	135	65
Mexico	16,766	360	14,015	318
Netherlands	--	--	441	338
South Africa, Republic of	26	12	45	26
Sweden	1,102	106	1,209	123
United Kingdom	4,336	736	3,437	1,139
Other	12	3	315	62
Total	283,431	11,259	312,040	14,741

Iron Oxide Pigments

By Henry E. Stipp [1]

Sales of finished iron oxide pigments in 1972 increased to record levels as the result of a rapidly expanding business cycle. Demand for iron oxide pigments, especially manufactured yellow, was very strong. Increased utilization of yellow iron oxide pigment was attributed to its application in paint formulations to replace lead compounds such as lead chromate, or chrome yellow. Paint containing lead concentrations greater than 0.06% lead has been banned for use in household interiors after December 31, 1973, by the U.S. Food and Drug Administration.

Although imports of iron oxide pigments increased substantially, they were not sufficient to satisfy the strong domestic demand. Imports of iron oxide pigments were curtailed by the strong economic expansion that occurred in West European countries in 1972, and by the effects of dollar devaluation and U.S. price controls. Normally, imports supplement domestic production of iron oxide pigments and supply a significant part of the domestic market.

DOMESTIC PRODUCTION

Production of finished iron oxide pigments, as indicated by sales in 1972, increased 35.9% to a record 174,392 short tons. The value of finished iron oxide pigments in 1972 increased 30% to $40.3 million. Yellow iron oxide recorded the greatest percentage increase among the manufactured varieties, and metallic brown oxide showed the largest increase among the natural iron oxide colors. Twelve companies operated 18 plants in nine States in 1972. Pfizer, Inc. was the major producer, with plants in California, Illinois, and Pennsylvania.

Production of crude iron oxide pigments decreased substantially for the fourth consecutive year. Figures for production and sales were withheld in 1972 to avoid disclosing company confidential data. Five companies operating mines or plants in five States reported production of crude iron oxide pigments. The Cleveland-Cliffs Iron Co. produced the largest quantity from mines in Michigan.

Expansion of facilities by Pfizer, Inc. in Illinois and California was completed by August, and supplies of finished iron oxide pigments were expected to increase substantially by yearend.

[1] Physical scientist, Division of Ferrous Metals.

Table 1.—Salient iron oxide pigments statistics in the United States

	1968	1969	1970	1971	1972
Mine production ... short tons	57,600	40,600	38,600	W	W
Crude pigments sold or used ... do	57,600	40,800	39,200	W	W
Value ... thousands	$457	$362	$442	r $415	$418
Finished pigments sold ... short tons	132,400	142,900	124,000	128,300	174,400
Value ... thousands	$31,000	$32,000	$28,000	$31,300	$40,300
Exports ... short tons	3,000	4,000	5,000	4,000	4,000
Value ... thousands	$1,000	$1,000	$2,000	$2,000	$2,000
Imports for consumption ... short tons	30,000	33,000	33,000	36,000	47,000
Value ... thousands	$4,000	$5,000	$6,000	$6,000	$9,000

r Revised. W Withheld to avoid disclosing individual company confidential data.

CONSUMPTION AND USES

Consumption of iron oxide pigments increased sharply in 1972 as the result of high levels of paint, lacquer, and varnish sales. Record high construction activity for the second consecutive year and increased sales of automobiles, appliances and furniture reportedly were responsible for the increased consumption of paint, lacquer, and varnish. Shortages of some grades of iron oxide pigments occurred as a result of overall economic expansion, dollar devaluation, and price controls. Domestic supplies of yellow iron oxide were inadequate and imports were curtailed by decreased shipments from abroad. Foreign producers preferred to sell their products overseas where they could obtain a higher price. Several new paint formulas were introduced that incorporated yellow iron oxide and yellow organic pigments as a replacement for yellow lead chromate. Inventories depleted in the last quarter of 1971 were being replaced during most of 1972, however increased consumption slowed inventory rebuilding. Micaceous iron oxide, imported from Austria, was gaining increasing acceptance as a primer for protection of iron and steel structures against corrosion. A new group of red and yellow synthetic iron oxides became available for use in automobile finishes, aluminum coatings, and stains.

Iron oxide pigments were used in paints, rubber, plastics, concrete products, paper, magnetic ink, fertilizers, and animal food. They were used also in ferrite applications such as television components, filters in radio equipment, computer memory cores, door latches and seals, small electric motors, and inductor and microwave devices. Iron oxide material was used in miscellaneous applications such as abrasives, welding rod coatings, soil conditioners, foundry sands, and automobile brake linings.

Data are not collected by the Bureau of Mines on specific uses for iron oxide pigments, and the figures given in table 2 do not necessarily reflect all sales of iron oxide pigment material for uses other than pigments.

Table 2.—Finished iron oxide pigments sold by processors in the United States, by kind

Pigment	1971		1972	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Natural:				
Brown:				
Iron oxide (metallic) [1]	13,453	$2,109	19,074	$3,467
Umbers:				
Burnt	4,441	1,136	5,376	1,441
Raw	1,196	309	1,541	435
Red:				
Iron oxide	27,518	1,938	35,541	2,547
Sienna, burnt	903	401	1,201	531
Pyrite cinder	(2)	(2)	(2)	(2)
Yellow:				
Ocher [3]	10,181	2,088	6,223	495
Sienna, raw	787	277	992	389
Total natural	58,479	8,258	69,948	9,305
Manufactured:				
Black: Magnetic	3,692	2,384	3,149	1,376
Brown: Iron oxide	6,272	2,284	6,539	2,748
Red:				
Pure red iron oxides:				
Calcined copperas	20,540	6,696	19,185	6,499
Other chemical processes	11,492	2,861	14,426	4,531
Venetian red	467	106	505	135
Yellow: Iron oxide	22,469	7,643	31,867	11,118
Total manufactured	64,932	21,974	75,671	26,407
Unspecified including mixtures of natural and manufactured red iron oxides	4,897	1,105	28,773	4,618
Grand total	128,308	31,337	174,392	40,330

[1] Includes black magnetite and Vandyke brown.
[2] Pyrite cinder included with red iron oxide for 1971 and 1972.
[3] Includes yellow iron oxide.

PRICES

Increases in price ranging from ½ cent per pound up to 1½ cents per pound were reported effective March 1 on selected items of manufactured iron oxide pigments. Further increases in price ranging from ¼ cent per pound to 2½ cents per pound were reported effective July 28 on most items of manufactured iron oxide pigments. Natural iron oxide pigment prices remained steady throughout the year, with the exception of imported Vandyke brown, which increased by 3½ cents per pound in October.

Table 3.—Prices quoted on finished iron oxide pigments, per pound, in bags, unless otherwise noted, as of December 31, 1972 [1]

Pigment	Low	High	Pigment	Low	High
Black:			Red:		
Pure	$0.1625	$0.1925	Domestic primers	$0.0775	$0.1050
Synthetic	.1788	.1875	Persian Gulf	.1375	.1400
Brown:			Pure synthetic	.1675	.1825
Pure, synthetic	.1775	.2125	Spanish, exdock, N.Y.[2]	.1100	.1175
Metallic	.0850	.1025	Yellow:		
Umber, American, burnt	.1225	.1450	Ocher, domestic	.0540	.0550
Umber, American, raw	.1250	.1450	Ocher, French type	.0975	.1175
Vandyke, imported [2]	.1550	.1900	Pure, light lemon	.1600	.1800
Sienna, American, burnt	.1750	.2000	Other shades	.1500	.1700

[1] Low and high range covers prices for carlots and less than carlots, at the works.
[2] Barrels.

Sources: Chemical Marketing Reporter and American Paint Journal.

FOREIGN TRADE

United States exports of iron oxide pigments in 1972 increased 7% to 4,268 short tons compared with exports of 3,984 short tons in 1971. Canada received the major share in 1972.

Imports of natural and manufactured

Table 4.—U.S. exports of iron oxide and hydroxides, by country

Destination	Pigment grade		Other grades	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Argentina	121	$39	27	$16
Australia	163	131	46	31
Belgium-Luxembourg	61	26	21	11
Brazil	155	99	50	44
Canada	1,777	633	894	475
Colombia	16	8	18	16
France	213	131	85	54
Germany:				
East	--	--	120	57
West	45	73	256	126
Guatemala	24	8	4	2
India	8	7	32	29
Italy	82	55	604	749
Japan	80	37	534	479
Mexico	161	88	185	138
Netherlands	5	8	236	282
Netherlands Antilles	8	3	2	1
New Zealand	12	4	--	--
Panama	11	5	12	7
Peru	9	4	17	15
Philippines	44	18	--	--
Portugal	--	--	29	22
South Africa, Republic of	2	5	31	26
Spain	15	8	28	7
Sweden	19	8	8	4
U.S.S.R.	--	--	230	172
United Kingdom	528	212	301	299
Venezuela	151	62	71	46
Vietnam, South	433	184	--	--
Other	125	70	85	53
Total	4,268	1,926	3,926	3,161

iron oxide pigments in 1972 increased 29.5% to 47,271 short tons compared with 36,496 short tons in 1971. The value of imports increased 38.6% in 1972 to $8.5 million compared with $6.2 million in 1971. Manufactured (synthetic) material constituted 72.5% of total U.S. imports. Crude and refined umber made up 63.4% of imports of natural iron oxide pigments. The major part of manufactured iron oxide pigments imported into the United States in 1972 came from West Germany, Canada, and the United Kingdom. U.S. imports of natural iron oxide came mainly from Spain, Iran, and France in 1972.

Table 5.—U.S. imports for consumption of selected iron oxide pigments

Kinds	1971		1972	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Natural:				
Ocher, crude and refined	--	--	93	$6
Siennas, crude and refined	1,427	$125	1,272	196
Umber, crude and refined	4,681	228	8,234	412
Vandyke brown	358	39	621	77
Other [1]	1,794	171	2,777	236
Total	8,260	563	12,997	927
Manufactured (synthetic)	28,236	5,592	34,274	7,602
Grand total	36,496	6,155	47,271	8,529

[1] Classified by the Bureau of the Census as "Natural iron oxide and iron hydroxide pigments, n.s.p.f."

Table 6.—U.S. imports for consumption of iron oxide and iron hydroxide pigments, n.s.p.f., by country

Country	Natural				Synthetic			
	1971		1972		1971		1972	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Austria	14	$2	15	$2	--	--	--	--
Belgium-Luxembourg	--	--	--	--	16	$3	19	$9
Canada	--	--	--	--	9,210	1,476	11,782	1,744
Cyprus	2	(1)	--	--	--	--	--	--
France	97	15	149	17	--	--	23	12
Germany:								
East	--	--	--	--	36	6	--	--
West	72	54	3	5	17,147	3,686	19,751	5,028
Iran	--	--	254	9	--	--	--	--
Italy	(1)	(1)	--	--	2	(1)	--	--
Japan	1	1	--	--	115	106	121	272
Mexico	--	--	--	--	--	--	5	1
Netherlands	1	1	--	--	21	29	137	88
Spain	1,598	92	2,234	168	85	5	20	2
Sweden	8	2	40	7	--	--	--	--
Switzerland	1	4	--	--	--	--	--	--
United Kingdom	--	--	82	28	1,604	281	2,416	446
Total	1,794	171	2,777	236	28,236	5,592	34,274	7,602

[1] Less than ½ unit.

TECHNOLOGY

A method of selecting pigments for manufacturing powder coatings was described.[2] The final selection of a pigment was reportedly dependent upon end-use requirements, application method, proper resin system, and method of manufacturing. Pigment properties that entered into the selection process were color, heat stability, chemical reactivity, hiding power, particle size, surface area, oil absorption, electrical

[2] American Paint Journal. The Colorful Choice In Powder Coatings. V. 56, No. 46, May 1, 1972, pp. 16–22.

properties, migratory properties, and weatherability.

Ferrites were proposed for use in identifying tanker ships involved in oil spills.[3] The ferrite powder would be introduced into the oil when the tanker took on its load of petroleum. Each batch of ferrites would have different magnetic properties. When an oil spill occurred, the various magnetic properties of the ferrites could be decoded and the polluting ship identified by the code assigned to it. During unloading of the oil cargo the suspended ferrites could be removed by a magnetic filter. Scientists estimate that 11 variations of the ferrite composition would yield 2,000 different codes. About 1 ton of ferrite material would be required for a 100,000-ton vessel.

Iron oxide powders of submicron size were prepared by precipitation of iron hydroxide with ammonium hydroxide from a solution of iron chloride. The colloidal precipitate was heat treated in a fluidized bed.[4] The iron oxide of submicron size gave superior performance when utilized as a pigment material in paint and when sintered with other metal oxides in preparing ferrite compounds.

A new ferrite material that was less sensitive to temperature changes was developed.[5] Lower memory core manufacturing costs and improved computer reliability was indicated by use of the new material. The new ferrite enables memory cores to operate from −25° C to 100° C without special temperature-controlling equipment.

A relatively low-cost process for regenerating pickle liquor with the production of iron oxide as a byproduct was reported.[6] Armco Steel Corp. started up a $4.25 million system at its Ashland, Ky., works that converts all the plant's spent pickle liquor into fresh hydrochloric acid. The system will regenerate about 90% of all the hydrochloric acid consumed at the Ashland works. Iron oxide is precipitated in the form of a fine powder of nearly pure grade. The process, sublicensed to Pennsylvania Engineering Corp., Pittsburgh, Pa., makes use of new technology and both plastic and titanium materials. Use of the process reportedly could save up to $7 per ton to dispose of the spent pickle liquor and $28 per ton for new hydrochloric acid. In addition, sale of the iron oxide would supplement the other savings.

[3] Wall Street Journal. Culprits In Oil Spills Face GE Sleuthing by Magnetic Seeding. V. 180, No. 92, Nov. 10, 1972, p. 25.

[4] Materials Science And Engineering. Some Developments in Iron Oxide and Iron Metal Submicron Powder Preparation Technology. V. 9, No. 2, February 1972, pp. 87–95.

[5] Wall Street Journal. Ampex Says New Material Will Help Memory Cores. V. 179, No. 90, May 9, 1972, p. 16.

[6] American Metal Market. Solution For Pollution—Pickle Liquor Recovery Saves $$. V. 79, No. 190, Oct. 17, 1972, pp. 12–13.

Kyanite and Related Minerals

By J. Robert Wells [1]

Kyanite, andalusite, and sillimanite are anhydrous aluminum silicate minerals that are closely akin in both composition and use patterns and have the same chemical formula, $Al_2O_3.SiO_2$. Closely related materials include synthetic mullite, dumortierite, and topaz, also classed as aluminum silicates. The latter two additionally contain boron and fluorine, respectively. All of these substances have the capability of serving as materials for the manufacture of special-duty refractories of the high-alumina category. There has been no record in recent years, however, of significant utilization of either dumortierite or topaz for this purpose in the United States.

Although not enough statistics are published to be wholly conclusive, it appears that the United States, India, and the Republic of South Africa hold the lead among world producers of kyanite-group minerals and that they may be not far from evenly matched in that regard. Presumably, the U.S.S.R. and some other industrialized nations also produce significant quantities of these materials.

Domestic production of kyanite plus synthetic mullite dipped moderately in tonnage in 1972, the first such downturn since 1968. Total value of these two materials, which showed a steep drop in 1971 from the peak reached in 1970, sagged again in 1972, though less sharply. These declines may have resulted from the slackness in shipments of finished brick and shape kyanite-mullite refractories that was noted in the 1971 Minerals Yearbook chapter, a trend that was even more marked in 1972. Total value of shipments of mullite brick and shapes made predominately of kyanite-group minerals or synthetic mullite (exclusive of molten-cast products) was 10% lower in 1971 and 28% lower in 1972 than in 1970. Mullite-based mortars, ramming mixes, and castable refractories presumably held up well, because total value of all nonclay refractories followed a 6% decline in 1971 with a 12% increase in 1972.[2] In ample compensation for any reduction in domestic consumption of the mullite refractories, exports of kyanite and allied materials scored a spectacular increase in 1972 with regard to both quantity and total value. Kyanite imports, meanwhile, fell to their lowest level in over 30 years.

Legislation and Government Programs.—The 1970 revision of the list of strategic materials for stockpiling excluded kyanite-mullite. At that time Government holdings totaled approximately 4,800 short tons of that commodity, and Congress authorized the stepwise disposal of the entire quantity by public sale. Notices dated November 23, 1971, January 19, 1972, June 27, 1972, and October 27, 1972, invited bids for the as-is sale of portions of this material, but no acceptable offers were received.

The Office of Minerals Exploration offered to grant Government loans up to 50% of approved costs for the exploration of eligible kyanite deposits, but no loans for that purpose were made in 1972.

---

[1] Physical scientist, Division of Nonmetallic Minerals.

[2] U.S. Department of Commerce, Bureau of the Census. Current Industrial Reports, Series: MQ-32C; Summary for 1971; First, Second, Third, and Fourth Quarters 1972.

DOMESTIC PRODUCTION

Kyanite was produced in the United States in 1972 from three open pit mines, two in Virginia and one in Georgia. In addition to the hard-rock production, a minor quantity of kyanite-sillimanite concentrate was recovered in the process of extracting titanium and zirconium minerals from a beach sand deposit in Florida. 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. E. I. du Pont de Nemours & Co., Inc., operated the Trail Ridge mine and mill in Clay County, Fla.

Domestic kyanite output in 1972, as measured by the quantity sold or used, was fractionally lower in both tonnage and total value than in 1971. Specific kyanite production statistics for 1972 (as well as for all previous years since 1949) are withheld because the predominant position of the two major producers would make publication of even national totals a disclosure of each firm's confidential data.

Synthetic mullite, produced in 1972 by eight companies at operations in seven States, amounted to 16% less in tonnage than in 1971 and 18% less in total value. The 1972 output consisted predominantly of high-temperature sintered material, the average unit value of which was substantially below that reported for fused material. Leading in tons produced were Babcock & Wilcox Co., Richmond County, Ga.; Mullite Corp. of America, Sumter County, Ga.; H. K. Porter, Inc., Fairfield County, Conn.; and Charles Taylor & Sons, Inc., Greenup County, Ky.; whose combined outputs amounted to 86% of the 1972 national total.

Table 1.—Synthetic mullite production in the United States

(Short tons and thousand dollars)

Year	Quantity	Value
1968	36,014	5,758
1969	48,588	6,847
1970	55,516	8,840
1971	55,077	4,945
1972	46,389	4,080

CONSUMPTION AND USES

Kyanite and related minerals, conforming to the established end-use pattern, were consumed in 1972 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 separating it from the accompanying quartz gangue, was marketed in the raw form or after heat treatment, as mullite, which was sometimes further reduced in particle size. In the 35- to 48-mesh range, the mineral was employed mostly in refractories applications such as for high-temperature mortars or cements, ramming mixes, and castable refractories, or with clays and other ingredients in refractory compositions for the making of kiln furniture, insulating brick, firebrick, and other refractory articles of a wide variety of types. More finely ground material, minus 200 mesh for example, was used especially in body mixes for sanitary porcelains, wall tile, precision casting molds, and miscellaneous special-purpose ceramics.

PRICES

Engineering and Mining Journal, December 1972, listed the following prices per short ton (unchanged from December 1971 quotations) for kyanite, f.o.b. Georgia, in bags (bulk shipments $2.00 less per ton):

	Per short tons
35 mesh	$58
48 mesh	62
100 mesh	65
200 mesh	73
325 mesh	Nominal

Prices and price ranges for kyanite-group minerals quoted by Industrial Minerals (London), December 1972, were as follows (after conversion from pounds sterling per long ton to dollars per short ton):

	Per short ton
Andalusite, Transvaal, c.i.f. main European port	$51–$56
Kyanite, Indian, c.i.f. main European port	65–79
Sillimanite, Indian, natural, f.o.b. Calcutta	83
Silimanite, Indian, calcined, f.o.b. Calcutta	94

FOREIGN TRADE

An impressively larger quantity of kyanite-group material was exported from the United States in 1972 (to a total of 23 countries) than in any previous year. Large shipments by sea in the year's last quarter, especially from Savannah, Ga., helped to bring the total tonnage to the highest point in history, more than double the 1971 figure. The average unit value of 1972 exports, $50 per short ton, compared with $65 to $70 per ton in recent years, hinted that a greater proportion of the material than in previous years may have been mullite derived from high-temperature calcination of clays, rather than by treatment of kyanite or by synthesis from SiO_2 and Al_2O_3 materials.

Kyanite-group imports in 1972 continued the downward slant that became evident in the early 1950's and declined to less than one-tenth of the 1971 figure and to less than one-fortieth of that of a decade ago, virtually ceasing to be an item of consideration in the U.S. trade balance. For the first time in may years, India was listed as the sole supplier.

Tariff regulations applicable throughout 1972 provided for the duty-free importation of kyanite, sillimanite, andalusite, and dumortierite. The duty on mullite, which amounted to 10% ad valorem in 1970, was reduced to 9% ad valorem on January 1, 1971 and to 7½% ad valorem on January 1, 1972.

Table 2.—U.S. exports and imports for consumption of kyanite and related minerals

	1970		1971		1972	
	Short tons	Value	Short tons	Value	Short tons	Value
Exports:						
Argentina	245	$18,375	257	$20,404	112	$7,797
Australia	715	55,642	565	45,434	357	26,468
Belgium-Luxembourg	739	48,004	221	18,658	2,177	140,756
Canada	6,765	443,911	5,698	412,310	5,708	419,689
Colombia	--	--	661	37,791	312	19,399
Denmark	12	630	--	--	1,094	96,133
France	285	34,240	717	80,584	492	56,116
Germany, West	2,707	170,246	1,502	92,571	18,292	840,785
Italy	2,996	229,425	9,961	533,850	8,477	435,069
Japan	2,168	167,869	2,166	180,319	25,338	1,035,628
Mexico	2,435	164,591	1,877	128,057	1,775	118,482
Netherlands	--	--	2,635	187,840	6,561	262,610
Philippines	75	5,877	170	17,635	189	19,359
South Africa, Republic of	41	6,044	157	8,230	17	1,083
Sweden	1,217	72,775	2,609	163,405	731	42,542
Taiwan	309	8,823	--	--	9	570
Thailand	61	3,800	10	834	--	--
United Kingdom	2,213	122,757	1,461	103,652	1,446	107,996
Venezuela	780	46,437	583	41,597	558	52,485
Other	r 261	22,587	304	24,096	266	54,094
Total	24,024	1,622,033	31,554	2,097,267	73,911	3,737,061
Imports:						
France	1	290	1	1,612	--	--
India	1,178	55,264	1,301	60,743	124	5,773
South Africa, Republic of	--	--	41	2,891	--	--
Total	1,179	55,554	1,343	65,246	124	5,773

r Revised.

WORLD REVIEW

Although in most cases little or no statistical information is available, significant production of kyanite-group minerals and materials in recent years has been reported in Australia, Brazil, France, India, Kenya, Malawi, Mozambique, Rhodesia, Republic of South Africa, Republic of Korea, Spain, Territory of South-West Africa, the United Kingdom, and the United States. Interest has been expressed in kyanite deposits in Canada and Norway also, but no commercial production has yet been recorded in those countries. The U.S.S.R. and others among the more industrialized countries doubtless either produce or consume substantial quantities of the kyanite minerals, but pertinent data have not been made public.

Australia.—The annual totals for Australian sillimanite production in the fiscal years ending June 30, 1969, 1970, and 1971, amounted to 2,137, 1,295, and 1,255 short tons, respectively.[3] Recovery of commercial quantities of kyanite and a number of other coproduct minerals is expected to be feasible when full-scale development is reached at a Du Pont sponsored ilmenite-rutile operation at Eneabba, 150 miles north of Perth in Western Australia. Discovery was announced of a potentially valuable kyanite deposit, also in Western Australia, and plans were made to establish facilities for its exploitation.

Canada.—Dumortierite was one of the minerals found to occur in significant amounts in a quartz-feldspar porphyry dike abutting the ore body at Canada's second-largest copper mine on the north end of Vancouver Island, British Columbia. Plans for commercializing the discovery were not mentioned.[4]

Germany, West.—Imports by West Germany of sillimanite minerals (including andalusite and kyanite) amounted to 43,000 tons in 1970 and 30,000 tons in 1971.

India.—Production of Indian kyanite decreased from 131,171 tons in 1970 to 92,638 tons in 1971. Production of sillimanite declined also, although less markedly, from 5,029 tons in 1970 to 4,722 tons in 1971. Exports accounted for 54% and 41% of the 1971 kyanite and sillimanite outputs, respectively. The United Kingdom, West Germany, Italy Japan, and the Netherlands were the principal recipients of the exported material. The Government of India announced that, as of April 1, 1972, all exports of sillimanite will be channeled through the state-owned Minerals and Metals Trading Corp. Mines in the Khasi Hills district of India's remote state of Assam are the world's foremost source of sillimanite, which is valued for the manufacture of special-purpose refractories that are denser and more resistant to abrasion and thermal shock than those based on synthetic mullite. High cost and limited supply, both occasioned by the inaccessibility of the deposits and the expense of transportation (first for long distances over difficult roads, then by river boat down the Brahmaputra to Calcutta) are cited as the principal influences restricting utilization of this mineral.

Israel.—An industrial journal published an article describing the installations and operations of Koors Industries, Hasin-Esh division, which manufactures mullite-type refractories from raw materials mined in Israel's Negev Desert. The resulting products are mostly consumed by the domestic steel, cement, chemical, and ceramic industries.[5]

South Africa, Republic of.—Output of kyanite-group minerals in 1971, the last year for which complete data are available, amounted to 49,020 tons of andalusite and 19,246 tons of sillimanite. Comparable figures for 1970 were 46,872 tons and 23,690 tons, respectively. Exports in 1971 accounted for 41% of the output of andalusite and exceeded that of sillimanite by 7%. Exports in 1970 amounted to 56% and 88% of the respective outputs.

United Kingdom.—The Highlands and Islands Development Board issued a report cataloguing observed mineral occurrences on Scotland's Isle of Skye and mainland Ross and Cromarty County. Kyanite was one of the minerals specifically listed, but no information was released concerning possibilities for commercial development.

---

[3] Industrial Minerals (London). Australian Production of Industrial Minerals. No. 64, January 1973, p. 27.

[4] Mining Magazine (London). Island Copper Project. V. 127, No. 4, October 1972, pp. 344–345, 347.

[5] Svec, J. J. Israeli High Alumina Refractories at Home and Abroad. Brick & Clay Record, v. 160, No. 2, February 1972, pp. 32–33.

TECHNOLOGY

In its annual review of materials for ceramic processing, an industrial journal presented informative thumb-nail studies of the kyanite-group minerals and their contributions to modern technology.[6] The research program of the Bureau of Mines included an investigation of beneficiation procedures applicable to kyanite-bearing materials from Idaho. A patent was issued for a process by which kyanite or other aluminosilicate ores can be treated with chlorine to volatilize undesired iron and titanium, leaving residues enriched in aluminum and silicon that can be smelted to produce alloys of these two elements.[7]

Mullite, synthesized from pure silica and Bayer-process alumina (at least 99% Al_2O_3) and then shaped into spheres, was the refractory catalyst-support base selected for a catalytic-cracking process for the production of synthetic pipeline gas.[8] A tabulation was published listing the physical, mechanical, and electrical properties, maximum recommended service temperatures, and practical applications of certain special-purpose ceramics of the refractory mullite type.[9]

A series of articles in a British journal presented a wide-ranging study of modern refractories and of the technology of their production and utilization. Prominently featured among the materials discussed were the kyanite–mullite group of refractories. Included in one of the reports was a useful world-wide listing of principal refractories manufacturers.[10]

A number of articles were published dealing with theoretical and experimental considerations of potential importance for the future development of kyanite–mullite refractories technology.[11]

An article reviewed technologic criteria for choosing types of refractories for a specified application. Considerations discussed for mullite and other applicable materials included thermal conductivity, thermal expansion, specific heat, emissivity, bulk density, porosity-permeability, thermal-shock resistance, creep, and crushing strength and modulus of rupture at different temperatures. More briefly treated were the topics of refractory life expectancy and comparative costs.[12]

The installations, equipment, and methods in use by a major producer of mullite refractories were subjects dealt with in a two-part magazine article.[13] New facilities for the development of refractories technology were placed in service by a leading industrial refractories manufacturer, Kaiser Refractories. The Clay-Alumina Development and Applications section of the new facility specializes in research on aluminosilicate materials, including mullite.[14]

---

[6] Ceramic Industry Magazine. V. 100, No. 1, January 1973; Andalusite, p. 39; Dumortierite, p. 62; Kyanite, p. 74; Mullite, p. 88; Sillimanite, p. 102; and Topaz, p. 111.

[7] Hildreth, C. L. (assigned to Ethyl Corp.). Chloridizing Alumina-Containing Ore. U.S. Pat. 3,704,113, Nov. 28, 1972.

[8] Ceramic Age. Mullite Balls Help Produce SNG. V. 89, No. 1, January 1973, p. 4.

[9] Materials Engineering. Mechanical and Electrical Ceramics-Fired Parts. V. 76, No. 4, September 1972, p. 366.

[10] Industrial Minerals (London). An Introduction to Refractories. No. 58, July 1972, pp. 9–23.
———. Refractory Raw Materials—The Producers Reviewed. No. 59, August 1972, pp. 9–19.
———. The UK Refractories Industry. No. 61, October 1972, pp. 9–31.
———. Refractories in the USA. No. 62, November 1972, pp. 9–11, 13–14, 17, 19–23, 25, 27.

[11] Davis, Robert F., Ilhan A. Aksay, and Joseph A. Pask. Decomposition of Mullite. J. Am. Ceram. Soc., v. 55, No. 2, February 1972, pp. 98–101.
Davis, Robert F., and Joseph A. Pask. Diffusion and Reaction Studies in the System Al_2O_3-SiO_2. J. Am. Ceram. Soc., v. 55, No. 10, October 1972, pp. 525–531.
MacKenzie, K. J. D. Infrared Frequency Calculations for Ideal Mullite ($3Al_2O_3.2SiO_2$). J. Am. Ceram. Soc., v. 55, No. 2, February 1972, pp. 68–71.
Mazdiyasni, K. S., and L. M. Brown. Synthesis and Mechanical Properties of Stoichiometric Aluminum Silicate (Mullite). J. Am. Ceram. Soc., v. 55, No. 11, November 1972, pp. 548–552.
McGee, Thomas D., and C. D. Wirkus. Mullitization of Alumino-Silicate Gels. Am. Ceram. Soc. Bull., v. 51, No. 7, July 1972, pp. 577–581.
Penty, R. A., D. P. H. Hasselman, and R. M. Spriggs. Young's Modulus of High-Density Polycrystalline Mullite. J. Am. Ceram. Soc., v. 55, No. 3, March 1972, pp. 169–170.

[12] Russell G. A., Jr. Selection of Refractories for Modern Blast Furnace Stoves. Iron and Steel Eng., v. 49, No. 2, February 1972, pp. 42–48.

[13] Jeffers, P.E. CE Refractories—Part 1, A Profile on Progress; Part 2, An Organization of Specialists. Brick & Clay Record, v. 161, Nos. 1 and 2, July and August 1972, pp. 31–37, 43–44; and 17–21, respectively.

[14] Jeffers, P. E. Kaiser Consolidates Research in New $25-Million Lab. Brick & Clay Record, v. 160, No. 3, March 1972, pp. 26–27.

Lead

By J. Patrick Ryan [1]

World production and consumption of lead reached record levels and achieved a near balance in 1972. Free world mine production increased about 1% with most of the net gain coming from the United States and Peru. Refined lead production was up nearly 2% with most of the major producing countries contributing to the increase. Consumption of metal rose 4%, the largest annual increase since 1969. The near balance between metal production and consumption brought relatively stable world market prices, particularly in the London Metal Exchange (LME) quotation. The average LME cash price published by Metals Week in terms of U.S. currency increased from 11.40 cents per pound in January to 14.51 cents in March, and generally declining thereafter to 13.98 cents in December. The average equivalent LME price in 1972 was 13.68 cents. The average U.S. producers' price after rising 1.6 cents to 15.60 cents in the first 5 months trended lower thereafter to 14.50 cents in December. The average domestic price of lead on a nationwide delivered basis in 1972 was 15.03 cents per pound.

The domestic lead industry again achieved significant gains in both mine production and consumption. Refinery production also increased continuing the rising trend of recent years after a falloff in 1971, which was attributed to a reduction in imports of crude materials for processing at domestic plants. Both mine and refinery production of lead reached the highest levels since 1929 with respective gains of about 7% over 1971 output. The 40,360-ton net increase in domestic mine output was achieved as gains in Missouri and Colorado more than offset declines in Idaho and Utah. Secondary lead output of 616,600 tons, representing about 39% of the market supply, was nearly 20,000 tons more than the 1971 output. The apparent domestic supply of lead consisting of primary, secondary, and imports (table 1) amounted to 1.57 million tons, 104,000 tons more than that of 1971.

Demand for lead in transportation uses continued to grow as requirements for batteries and gasoline antiknock compounds increased 7% and 5%, respectively. The quantity of lead used in battery manufacture reached a record high, and lead used in antiknock additives was only slightly below the record achieved in 1970. Lead used in pigments, reversing a 3-year decline, increased 10% in 1972. Of the total lead consumption of 1.48 million tons, batteries accounted for 49%; antiknock compounds, 19%; ammunition, 6%; pigments, 6%; and solder, 5%.

Stocks of refined and antimonial lead at primary plants increased from 52,100 tons at the beginning of the year to 64,500 tons at yearend. Consumer and secondary stocks declined from 125,600 tons at the beginning of the year to 118,500 tons at yearend. Commercial sales and transfers for government use, totaling about 49,800 tons, reduced the uncommitted government stockpile of lead to 1,077,600 tons at yearend.

St. Joe Minerals Corp. closed its Federal mine in October after 50 years of continuous operation thus phasing out mining operations in the Old Lead Belt of Southeast Missouri.

Legislation and Government Programs.—Commercial sales of surplus lead by General Services Administration (GSA) from the Government stockpile and transfers for government use totaled 49,825 tons in 1972 compared with only 12 tons in 1971. The disposals were authorized under Public Laws 91–46 and 89–9. Public Law 92–356 enacted on July 26 authorized 498,000 tons for disposal; 100,000 tons was authorized earlier under Public Law 91–46.

[1] Mining engineer, Division of Nonferrous Metals.

Actual drawdown of government stocks during 1972 was 44,738 tons, leaving a total of 1,085,871 tons remaining in the stockpile on December 31. Of the total uncommitted inventory at yearend 547,615 tons was in excess of the 530,000-ton objective.

GSA concluded contracts in May with primary producers for the disposal of 575,000 tons of surplus stockpile lead. Under terms of the contracts producers were obligated to purchase metal at the rate of 50,000 tons per year subject to suspension during quarters when producers' stocks exceed one-tenth of the preceding year's shipment of primary metal. The long-term contracts were amended at yearend by reducing the point of suspension to one-twelfth of the preceding year's shipments and increasing the purchase requirement to 55,000 tons per year. The new rates were to become effective January 1, 1973.

A bill (H.R. 16388) to provide for an adequate supply of lead and zinc for consumption in the United States from domestic and foreign sources was introduced in August and referred to the Committee on Ways and Means. The bill included a proposal to increase tariffs on lead in imported concentrates, lead and zinc unwrought and wrought metals, lead and zinc waste and scrap, and manufactures of these metals when exceeding specified limiting quantities. The bill also provided for revising the quotas for lead and zinc in concert with changes in the annual consumption. The proposed act was designed to implement the Mining and Minerals Policy Act of 1970 by encouraging private enterprise. No further action was taken on the bill by the 92d Congress. Bills (S. 3136, H.R. 12958) were introduced in the 2d Session, 92d Congress to regulate the amounts of lead and cadmium that may be released from glazed ceramic or enamel dinnerware; other bills introduced in the Congress relating to the use of lead included the following: S. 607—which would reduce the amount of lead contained in lead-based paints for residential use and establish procedures to minimize hazards of lead-based paint in any existing housing; H.R. 15937—which would provide performance standards for emission control devices to reduce air pollution from used vehicles, which could affect the use of lead in gasoline. The enactment of the Noise Control Act of 1972, which sets limits on noise emission, could stimulate the use of lead as a noise suppressing material in construction and other equipment.

On February 23 the Environmental Protection Agency (EPA) published guidelines

Table 1.—Salient lead statistics

(Short tons unless otherwise specified)

	1968	1969	1970	1971	1972
United States:					
Production:					
Domestic ores, recoverable lead content	359,156	509,013	571,767	578,550	618,915
Value ____ thousands	$94,903	$151,635	$178,609	$159,679	$186,046
Primary lead (refined):					
From domestic ores and base bullion	349,039	513,931	528,086	573,022	592,658
From foreign ores and base bullion	118,271	124,724	138,644	76,993	103,001
Antimonial lead (primary lead content)	19,494	16,250	11,655	16,116	8,185
Secondary lead (lead content)	550,879	603,905	597,390	596,797	616,597
Exports of lead materials excluding scrap	8,281	4,968	7,747	5,925	8,376
Imports, general:					
Lead in ore and matte	87,836	109,252	112,406	65,998	101,514
Lead in base bullion	8	1,993	296	41	895
Lead in pigs, bars, and old	344,601	285,342	251,480	198,970	245,625
Stocks December 31 (lead content):					
At primary smelters and refineries	90,427	101,860	192,985	121,660	145,573
At consumer plants	78,900	126,404	133,502	125,577	118,544
Consumption of metal, primary and secondary	1,328,790	1,389,358	1,360,552	1,431,514	1,485,254
Price: Common lead, average, cents per pound [1]	13.21	14.93	15.69	13.89	15.03
World:					
Production:					
Mine	3,314,992	3,566,061	3,741,546	3,771,879	3,848,582
Smelter	3,250,514	3,553,458	3,628,422	3,500,868	3,725,534
Price: London, common lead, average, cents per pound	10.88	13.09	13.76	11.52	13.68

[1] Quotations for 1968–71 at New York and for 1972 on a nationwide, delivered basis.

in the Federal Register calling for a staged reduction in the lead content of gasoline and requiring that major oil companies provide at least one grade of unleaded gasoline—actually, 0.05 gram per gallon—by July 1, 1974. The proposed timetable for the reduction of lead in gasoline provided for a maximum lead content of 2 grams per gallon by January 1, 1974; 1.7 grams per gallon by January 1, 1975; 1.5 grams per gallon by January 1, 1976; and 1.25 grams per gallon by January 1, 1977.

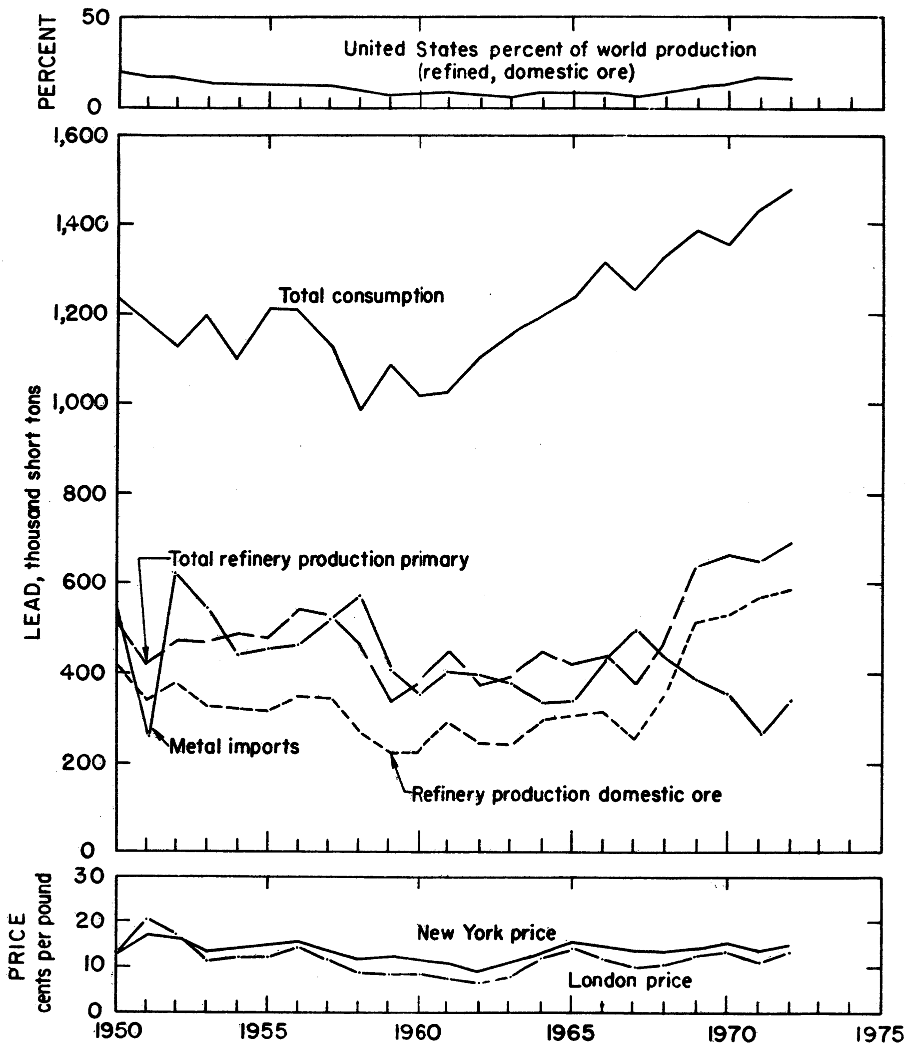

Figure 1.—Trends in the lead industry in the United States.

Table 2.—Lead statistics, 1931–72

(Short tons unless otherwise specified)

Year	United States							World production (mine)
	Mine production	Refinery production (primary sources)	Secondary production	Imports (refined) [1]	Exports	Consumption	Price (cents per pound)	
1931	404,622	442,764	234,700	10	21,665	567,700	4.24	1,461,000
1932	292,968	281,941	198,300	44	23,516	416,700	3.18	1,315,000
1933	272,677	263,676	224,500	109	22,835	449,500	3.87	1,304,000
1934	287,339	311,236	208,400	283	5,909	488,000	3.86	1,447,000
1935	331,103	324,560	270,400	1,322	6,982	538,900	4.06	1,523,000
1936	372,919	399,156	262,900	2,590	18,313	633,600	4.71	1,656,000
1937	464,892	467,317	275,100	4,903	20,091	678,700	6.01	1,863,000
1938	369,726	383,669	224,900	3,235	45,866	546,000	4.74	1,942,000
1939	413,979	484,035	241,500	7,139	74,392	667,000	5.05	1,902,000
1940	457,392	533,179	260,346	151,548	23,755	782,000	5.18	1,936,000
1941	461,426	570,967	397,416	274,189	14,359	1,050,000	5.79	1,784,000
1942	496,239	566,839	323,001	366,497	1,940	1,043,000	6.48	1,793,000
1943	453,313	469,612	342,094	244,510	2,003	1,113,000	6.50	1,591,000
1944	416,861	464,763	331,416	222,758	15,523	1,118,600	6.50	1,453,000
1945	390,831	443,585	363,039	227,469	1,408	1,051,600	6.50	1,302,000
1946	335,475	338,197	392,787	115,503	598	956,500	8.11	1,268,000
1947	384,221	441,010	511,970	159,513	1,523	1,172,000	14.67	1,498,000
1948	390,476	406,694	500,071	247,116	399	1,133,895	18.04	1,571,000
1949	409,908	477,338	412,183	275,240	969	957,674	15.36	1,709,000
1950	430,827	508,314	482,275	441,788	2,735	1,237,981	13.30	1,850,000
1951	388,164	417,693	518,110	179,032	1,281	1,184,793	17.49	1,890,000
1952	390,162	472,852	471,294	510,720	1,762	1,130,795	16.47	2,030,000
1953	342,644	467,891	486,737	385,071	803	1,201,604	13.48	2,100,000
1954	325,419	486,712	480,925	276,286	596	1,094,871	14.05	2,270,000
1955	338,025	479,157	502,051	264,149	403	1,212,644	15.14	2,430,000
1956	352,826	542,308	506,755	262,654	4,628	1,209,717	16.01	2,490,000
1957	338,216	533,533	489,229	324,279	4,339	1,138,115	14.66	2,640,000
1958	267,377	470,156	401,787	368,452	1,359	986,387	12.11	2,590,000
1959	255,586	340,931	451,387	263,416	2,756	1,091,149	12.21	2,570,000
1960	246,669	382,436	469,903	206,033	1,967	1,021,172	11.95	2,620,000
1961	261,921	449,565	452,792	256,852	2,133	1,027,216	10.87	2,640,000
1962	236,956	376,063	444,202	257,201	2,108	1,109,635	9.63	2,765,000
1963	253,369	394,732	493,471	227,027	1,088	1,163,358	11.14	2,775,267
1964	286,010	449,429	541,582	207,844	10,175	1,202,138	13.62	2,779,182
1965	301,147	418,249	575,819	222,613	7,811	1,241,482	16.00	2,966,508
1966	327,368	440,735	572,834	285,389	5,435	1,323,877	15.12	3,138,779
1967	316,931	379,894	553,772	363,598	6,536	1,260,516	14.00	3,159,343
1968	359,156	467,310	550,879	338,120	8,281	1,328,790	13.21	3,314,992
1969	509,013	638,655	603,905	278,380	4,968	1,389,358	14.93	3,566,061
1970	571,767	666,730	597,390	244,623	7,747	1,360,552	15.69	3,741,546
1971	578,550	650,015	596,797	195,587	5,925	1,431,514	13.89	3,771,879
1972	618,915	695,659	616,597	242,390	8,376	1,485,254	15.03	3,848,582

[1] 1931–39 includes a small quantity of scrap.

DOMESTIC PRODUCTION

MINE PRODUCTION

Domestic mine output of recoverable lead continued its uninterrupted rise since 1967 with an increase of about 7% in 1972 to 618,900 tons. Monthly production reached a maximum of 56,900 tons in August, slightly more than the maximum achieved in 1971. Production from Missouri mines increased 59,800 tons to 489,400 tons, representing 79% of the total domestic mine output. Idaho, the second largest producing State, provided 10%; Colorado, 5%; and Utah, 3%.

The Buick mine of AMAX Lead Co. of Missouri was again the leading lead producer with an output of 189,000 tons of lead concentrate in 1972. The seven leading mines, all in Missouri, contributed 74% of the total domestic mine production of lead. The 10 leading mines produced 84%, and the 25 leading mines contributed nearly 99%.

St. Joe Minerals Corp. closed its Federal mine in October and reported that its new Brushy Creek mine in the New Lead Belt with a production potential of 50,000 tons of lead per year is scheduled to start milling early in 1973. Although St. Joe reported a 3% increase in lead concentrate production to 312,700 tons, output of lead and lead alloy declined 6% to 207,877 tons. Operations at the company's Herculaneum smelter were interrupted by a 2-week work stoppage.[2]

[2] St. Joe Minerals Corp. 1972 Annual Report. Pp. 9, 17.

Ozark Lead Co.'s Ozark mine produced 69,100 tons of lead in concentrates compared with 55,300 tons in 1971. The production gain reflected a return to full-scale operation following a production curtailment in 1971 because of a buildup of concentrates during the period when the Glover custom smelter was closed by a labor strike.

Production of lead in Idaho was 5,200 tons less than in 1971. Increased output at the Bunker Hill and Star mines did not fully offset the loss in output at the Lucky Friday mine. Hecla Mining Co. reported[3] ore production of 263,595 tons at the Star-Morning mine, owned jointly by Hecla (30%) and Bunker Hill (70%), about 17,000 tons more than in 1971. Hecla's share of the 1972 silver-lead-zinc ore production was 79,079 tons assaying 5.33% lead and yielding 3,854 tons of lead. Extensive deep level development was completed, including deepening of No. 4 shaft to the 7,900-foot level and approximately 4,150 feet of development footage. Hecla's share of computed ore reserves increased 4,000 tons to 265,000 tons at yearend. Hecla's Lucky Friday mine produced 192,020 tons of ore assaying 10.43% lead, compared with 213,390 tons assaying 11.3% lead in 1971. Ore reserves at yearend totaled 584,000 tons, about 32,000 tons more than 1 year earlier. The main shaft was deepened to 30 feet below the 4,250-foot level, and a pilot station crosscut was completed at the 4,250 level. Crosscuts were completed through the vein on the new 4,050 level.

Output of lead in Utah declined about 46% in 1972. The Mayflower mine operated by Hecla Mining Co. produced 114,604 tons of ore yielding 3,586 tons of lead compared with 4,860 tons in 1971. The mine was closed at yearend.

Kennecott Copper Corp. reported that output of lead increased at its Burgin mine in the Tintic District, Utah, in 1972 owing to improved working conditions and the discovery of a new ore zone. The critical shortage of skilled miners continued to hamper mine development and production.[4]

In Colorado lead output, continuing the rising trend since 1968, increased nearly 22% in 1972. As in 1971 the production gain was attributed largely to increased output at the Leadville Unit, an American Smelting and Refining Co. (ASARCO)—managed joint venture with Newmont Mining Corp. ASARCO reported that in the first full year of operation of the new shaft, the Leadville mine produced 208,000 tons of lead-zinc-silver ore and recovered 7,400 tons of lead compared with 4,000 tons in 1971.[5] The mill operated somewhat below its capacity of 700 tons of ore per day during the year, but with the greater development of the No. 5 ore body, near capacity production is expected in 1973. Ore reserves at yearend were estimated at 2,609,000 tons averaging 5.16% lead, 9.92% zinc, and 2.53 ounces of silver and 0.068 ounce of gold per ton. Idarado Mining Co. mined and milled 386,500 tons of lead-zinc-copper ore in 1972 compared with 391,300 tons in 1971. Ore reserves at yearend were estimated at 2.86 million tons averaging 3.31% lead, 4.80% zinc, 0.74% copper, and 0.03 ounce of gold and 1.75 ounces of silver per ton.[6]

SMELTER AND REFINERY PRODUCTION

Continuing the rising trend since 1967, output of lead at primary refineries increased 7% in 1972. Gains were recorded in metal recovered from both domestic and foreign concentrates. Production from domestic primary sources increased 19,000 tons, and from foreign sources the gain was 26,000 tons. The 696,800 tons of primary refined lead produced in 1972 was the largest total output since 1929. About 85% of the total production was derived from domestic ores compared with 88% in 1971. An additional 1,200 tons was refined from scrap. Antimonial lead production declined for the fourth consecutive year with only 14,000 tons of lead recovered, of which 6,100 tons originated from domestic ores, 2,100 tons from foreign ores, and 5,800 from scrap. The antimony content increased by 1.0% to 7.0%.

The Herculaneum, Mo., smelter of St. Joe Minerals Corp. produced 207,900 tons of lead metal and alloys, about 14,000 tons less than in 1971. The production decline resulted from a 2-week work stoppage in April.

---

[3] Hecla Mining Co. 1972 Annual Report. Pp. 7–8.
[4] Kennecott Copper Corp. 1972 Annual Report. P. 22.
[5] ASARCO. 1972. Annual Report. P. 7.
[6] Newmont Mining Corp. 1972 Annual Report. Pp. 8–9.

AMAX Lead Co. of Missouri reported that the smelter at Buick, Mo., jointly owned by AMAX and Homestake Mining Co., produced 133,000 tons of refined lead, compared with 109,000 tons in 1971. Of the total output 67,000 tons were for the account of AMAX-Homestake, and the remainder was processed on toll for other producers.[7]

ASARCO's custom smelting and refining plant at Glover, Mo., operating at less than capacity because of market conditions, produced 86,400 tons of lead compared with 66,500 tons in 1971, a year in which the smelter was shut down for nearly 4 months by a strike. Most of the concentrate treated at the Glover plant came from the Ozark Lead Co. mine at Sweetwater, Mo. Concentrates from 13 other domestic mines in five States and from one mine in Honduras also were treated at Glover. The East Helena, Mont., smelter operated continuously during the year processing crude ores and concentrates from approximately 54 domestic mines and mines in Canada, Peru, and Australia. The El Paso lead smelter processed ores and concentrates from about 28 domestic mines in seven States and from mines in Peru, Canada, Honduras, Nicaragua, Australia, and Mexico. Refined metal output at the company's Omaha refinery, which processed lead bullion from the East Helena and El Paso smelters, totaled 142,700 tons, 20,200 tons more than in 1971 when production was interrupted by a 7-week labor strike.

The Bunker Hill smelter-refinery of Gulf Resources & Chemical Corp. at Kellogg, Idaho, produced 131,000 tons of lead in all forms, 2% more than in 1971 and a new record. The corporation attributed the increase in lead production to improved operating techniques at the smelter.[8]

RAW MATERIAL SOURCE

Domestic mines delivered 619,000 tons of recoverable lead in concentrates to domestic primary smelters in 1972. This represents 88% of the plant production of 703,800 tons of primary refined and antimonial lead compared with 87% in 1971 and 84% in 1970. Lead recovered from imported concentrate smelted during the year amounted to 105,000 tons, about 24,100 tons more than in 1971. The 7,000 tons of lead recovered from lead scrap processed at primary plants was nearly double the 1971 total but constituted only 1% of the total lead from primary plants. Raw material stocks at the beginning of the year at primary plants totaled 165,500 of which 84,400 tons was in process and 1,800 tons was in secondary materials. Total stocks trended upward from a low of 163,800 tons at the end of January to a high of 204,000 tons at the end of November. At yearend, stocks of primary materials awaiting processing contained 92,900 tons of lead, material in process 101,900 tons, and secondary materials 2,500 tons, making a total of 197,300 tons.

Scrap materials consumed in 1972 totaled 814,400 tons, nearly 30,000 tons more than in 1971. New scrap in the form of purchased drosses and residues from a wide variety of sources aggregated 158,900 tons, about 19% of the total input. The remainder, old scrap, was predominantly battery scrap with small amounts of cable lead, type metal, solder, babbitt, and soft and hard lead. The scrap processed was essentially all from domestic sources. General imports of reclaimed scrap, mainly from Australia, totaled 3,200 tons (lead content), slightly less than in 1971, but exports of lead scrap totaling 35,200 tons were about double those in 1971. Stocks of scrap at smelters at yearend were nearly 66,300 tons, about 7,300 tons less than at yearend 1971.

CONSUMPTION AND USES

Lead consumption in the United States increased nearly 4% in 1972 to a new record of 1.48 million tons. Monthly requirements were higher than those of 1971 in every month except July and September. All major product categories required greater quantities of lead than in 1971. In the metal products category, the 46,800-ton (7%) increase in battery requirements more than offset decreases in the quantity of lead used in ammunition, cables, calking, tubes, sheet lead, and other products. The growth in battery lead requirements

[7] AMAX. 1972 Annual Report. P. 17.
[8] Gulf Resources & Chemical Corp. 1972 Annual Report. P. 23.

largely reflected continued increase in the population of both on-the-road and off-the-road motor vehicles using battery power for starting, lighting, ignition, and propulsion. A total of 55.5 million automotive batteries were produced in 1972, about 43.2 million of which were required for replacement and the remainder for new car production. The growth in antiknock requirements was resumed in 1972 after a 5% decrease in 1971. The quantity of lead used in gasoline antiknock compounds increased 5% to 278,340 tons, only slightly less than the record consumption in 1970. The gain in lead antiknock additives reflected continuing growth in gasoline production and an increase in the average lead content per gallon of gasoline, from 2.59 grams per gallon in 1971 to 2.63 grams per gallon in 1972.

Soft refined lead represented 65% of the total consumption, antimonial lead 29%, and lead in other alloys, mainly solder and bearing metals, accounted for 5%. Lead in copper-base scrap accounted for 1% of consumption.

The domestic supply of lead metal from all sources—production, imports for consumption, stock changes, and stockpile releases—totaled about 100,000 tons more than reported consumption and exports. The unaccounted for supply in 1972, amounting to about 7% of reported consumption compares with an annual average of approximately 64,000 tons for the 1963–72 period. The difference in totals is attributed to unreported consumption and stock buildup, especially by small users and dealers that do not report to the Bureau of Mines.

The compound annual growth rate in lead consumption during the 10-year period 1963–72 averaged about 2.5% owing largely to the increased demand from the transportation sector for batteries and gasoline additives, which together showed an annual growth of 4.8% and accounted for approximately 68% of the total domestic consumption in 1972, but only 54% in 1963.

Pigments and weights and ballast uses also showed significant growth, but lead consumption in most other metal products was less than in 1971. In 1963 the use of lead in various products in terms of percent of total was as follows: Batteries 39%, other metal products 32%, pigments 8%, chemicals including antiknock compounds 17%, and miscellaneous and other unclassified uses 3%. In 1972, the comparative percentages were as follows: Batteries 49%, other metal products 23%, pigments 6%, chemicals including antiknock compounds 19%, and miscellaneous and other unclassified uses 3%.

LEAD PIGMENTS

Lead requirements for the production of lead oxides and pigments totaled 450,900 tons, about 6% more than in 1971. The quantity of lead used in making white and red lead was virtually the same as in 1971 and constituted about 6% of the total lead consumed in pigments. White lead requirements in 1972 were little more than one-half those 10 years ago, whereas the quantity used in red lead was only slightly less. Litharge production and shipments were about the same as in 1971 but were substantially greater than in 1963. Most of the litharge shipments went to battery manufacturers and is included in "Other." This category comprising 77% of the total shipments has increased from 72,400 tons in 1963 to 113,700 tons in 1972. Litharge for use in ceramic glazes amounting to 16% of the total shipments was slightly less than in 1971.

Shipments of white lead exceeded production, but red lead shipments were less than production. In 1972, shipments of litharge continued to exceed production for the eighth consecutive year, indicating a continued drawdown in stocks.

Prices.—Although more frequent then in 1971, lead pigment price changes were relatively moderate during the year. The price of basic carbonate white lead in carload lots, freight allowed, remained virtually unchanged at 22.3 cents per pound during the first 6 months. In July the price was increased to 23.9 cents per pound and remained unchanged thereafter to yearend. The quoted price of red lead oxide (Pb_3O_4) in carload lots, at works, was advanced from 17.75 cents in January to a range of 18.50–18.95 cents in February, 18.95–20.45 cents in May and 20.0–20.45 cents in June, remaining unchanged to October when the price quotation was reduced to 19.25 cents. The price was reduced again in December to a range of

18.75–18.90 cents. The price quotation of commercial-grade litharge, powdered, in carload lots, at works, ranged between 17.75–18.00 cents per pound and 19.25–19.50 cents during the year and was 18.00 cents at yearend, the same as at the beginning of the year.

The value of shipments of white lead, red lead, and litharge amounted to $61.1 million, an average of $344 per ton compared with $57.1 million and $325 per ton, respectively, in 1971.

Foreign Trade.—Exports of pigment-grade lead oxides total 1,866 tons valued at $818,400 and exports of lead oxides other than pigment grade amounted to nearly 500 tons valued at $455,600. Shipments went to about 36 countries. Canada, South Vietnam, West Germany, Italy, Japan, and Trinidad were the leading importers of pigment-grade lead oxide, accounting for 80% of the total. Canada, West Germany, Japan, and Netherlands received nearly 85% of the nonpigment-grade oxide exported.

Imports for consumption of lead pigments and compounds decreased 5% in quantity but increased 21% in value to $9.2 million. Litharge which comprised 58% of the total imports increased 4%, but imports of red lead decreased 74%. Mexico supplied nearly all of the 15,360 tons of litharge and 1,290 tons of red lead imported.

STOCKS

Inventories of refined and antimonial lead at primary smelters and refineries declined through the first 4 months as shipments exceeded production then increased steadily through September falling off again at yearend. Metal stocks totaling 52,100 tons at the start of the year increased to 64,500 tons at yearend. Stocks of base bullion declined about 2,300 tons during the year, but ore and matte stocks increased 13,800 tons.

Stocks of lead in all forms at consumer and secondary smelting plants totaled 118,500 tons at yearend, which reflects a 7,000-ton reduction during the year. Refined soft lead constituted 62% of the total compared with 65% of the total in 1971.

Stocks of lead at producers and consumers plants totaling about 264,000 tons, represented slightly more than 2 months' domestic consumption.

PRICES

Although the quoted price range of common-grade lead on a nationwide delivered basis was 14.0 to 14.3 cents, the producer price based on the weighted average of domestic sales as reported by Metals Week remained unchanged through January at 14.0 cents per pound. Two price changes in February raised the price to 15.5 cents, which held until mid-April when a split quotation of 15.5 to 16.0 cents again developed because some producers raised their price. The average price in April and May was 15.6 cents. Thereafter an average price of 15.5 cents held until late in August when one major producer lowered its price 0.5 cent to 15.0 cents and the split quotation became 15.0 to 16.0 cents. In mid-October the quoted price range became 14.5 to 16.0 cents when one producer reduced its price 0.5 cent to 14.5 cents. The price reduction reflected an increased supply situation attributed to gains in imports, metal inventories, and GSA releases. The split price quotation of 14.5–16.0 cents per pound continued unchanged through December; however, virtually all sales were made at 14.5 cents. Hence the weighted average producers' price of lead at yearend was 0.5 cent more than at the beginning of the year. The spread between the average domestic price of lead and the average equivalent London Metal Exchange (LME) spot quotation narrowed during the year from 2.6 cents in January to 1.4 cents in September and 0.5 cent in December. The average weighted domestic price for the year was 15.0 cents per pound.

The LME average spot quotation trended upward from a low of £97.80 per metric ton in January to £123.79 in September and to £131.39 in December. The equivalent price in terms of U.S. dollars was 11.40 cents per pound in January, 13.71 cents in September, and 13.98 cents in December; the average for the year was 13.68 cents (using a Sterling exchange average of 250.08 cents) compared with an average price of 11.52 cents in 1971.

The relative stability in the domestic price of lead in 1972 was attributed largely to the near balance between supply and demand during most of the year. Some softening of the market developed whenever excess inventories developed in relation to metal consumption. Selling prices for lead were well below the price ceiling of 16.5 cents established under U.S. price control regulations.

FOREIGN TRADE

Exports of lead materials during 1972 aggregated 43,600 tons valued at $8.8 million, compared with 23,000 tons valued at $6.2 million in 1971. Wrought and unwrought metal constituted 19% of the total exported; the remaining 81% was contained in scrap materials, most of which was shipped to Canada.

Reversing the declining trend since 1967, general imports of lead materials increased 31% in 1972 to a total of 348,000 tons valued at $84.5 million. Receipts of lead in concentrates and other crude materials were about 36,000 tons more than in 1971 and metal receipts increased 46,800 tons to nearly 242,400 tons. The quantity of lead in ores and concentrates received exceeded the quantity entered duty paid for consumption by nearly 50,000 tons, indicating a buildup of lead ores in bond. Canada continued to be the leading supplier of crude lead materials with 30% of the total, followed by Peru, Australia, and Honduras. Canada also continued to be the leading metal supplier with 34% of the total followed by Peru 20%, Australia 15%, Mexico 15%, and the United Kingdom 5%.

WORLD REVIEW

In 1972 mine production of lead in non-Communist countries (including Yugoslavia), depending on the reporting base and source, and scope of estimating, ranged from 2.89 million tons based on data compiled by the Bureau of Mines, through the International Lead and Zinc Study Group preliminary total of 2.82 million tons to the American Bureau of Metal Statistics (ABMS) total of 2.73 million tons. Bureau of Mines data, which indicate the basis used insofar as possible, depend largely on government information, as do those of the Study Group, although a somewhat different basis is used by the Study Group. ABMS relies largely on company and industry association sources. The Bureau of Mines estimated production in Communist countries (excluding Yugoslavia) at 0.96 million tons and the world total at 3.85 million tons, an alltime record high. Smelter output of lead is reported by the Bureau of Mines as primary output, insofar as possible, whereas the Lead and Zinc Study Group reports metal output from both primary and secondary sources. Thus, smelter output in 1972 in non-Communist countries, ranged from the Study Group preliminary total of 3.32 million tons through the ABMS total of 2.95 million tons to the Bureau of Mines total of 2.77 million tons. In addition the Bureau of Mines estimated 0.95 million tons of metal produced in Communist countries (excluding Yugoslavia) to provide a world total of 3.73 million tons of primary lead. The ABMS estimate for the same Communist countries was 1.07 million tons for a world smelter production of 4.02 million tons of lead.

The United States maintained its rank as the leading mine producer of lead in 1972, accounting for approximately 16% of the world total, followed by the U.S.S.R., Australia, Canada, Peru, Yugoslavia, and Mexico each with production exceeding 100,000 tons of lead in ore mined; these seven countries produced 67% of the world total. Non-Communist country lead output increased about 2% because production gains from mines in the United States, Peru, and Yugoslavia more than offset the loss in Canada. The North America area increase was about 3% and the 1.24 million tons produced represented 43% of the non-Communist country total and 32% of the estimated world total.

The United States also continued to be the leading producer of primary lead metal as well as secondary lead. The U.S.S.R. again ranked second, followed by Australia, Japan, Canada, Mexico, France, West Germany, People's Republic of China, and Spain. The 10 countries each produced more than 100,000 tons and together accounted for 72% of the world total. The North America area accounted for 34% of the non-Communist country metal output and 29% of the estimated world output (excluding U.S. secondary production). The 8% gain in non-Communist country primary metal output came chiefly from increases in the United States, Canada, Mexico, Peru, France, Spain, Australia and Japan. The smelter output data for some countries, particularly France, Japan, and West Germany, includes secondary metal.

According to preliminary data compiled by the International Lead and Zinc Study Group (ILZSG), non-Communist country consumption of lead in 1972, including primary and secondary metal, amounted to 3.73 million tons, about 5% more than in 1971. Most of the increase came from European countries. ILZSG non-Communist country comparative statistics on metal production and consumption indicate a supply deficit of about 74,000 tons in 1972 compared with an indicated surplus of nearly 16,000 tons in 1971. However, the indicated production deficit was not reflected in producers' stocks, which increased about 40,000 tons during the year to 266,000 at yearend. Consumer's stocks in the United States, United Kingdom, and Japan combined declined about 4,300 tons to 145,000 tons at yearend.

Trade data for the first 9 months of 1972 compiled by ILZSG disclosed that imports of lead bullion and refined lead into Socialist countries from the rest of the world totaled about 45,000 tons, 3,000 tons more than exports.

Algeria.—Société Nationale de Recherche et d'Exploitation Minière (Sonarem), the Algerian state mining agency, initiated an expansion and reconstruction program at the El Abed lead-zinc mine to increase production from 800 to 3,300 tons per day. The El Abed ore body is an extension of the Bou Beker-Touissit ore deposit across the border in Morocco. Total ore reserves at El Abed were estimated to contain 68,000 tons of lead and 391,000 tons of zinc.

Australia.—Mine production of lead increased nearly 2% to 451,000 tons. The production gain was largely attributed to increased output at Broken Hill mines and at the Rosebery mine in Tasmania.

M.I.M. Holdings Ltd. reduced production of silver-lead-zinc ore at its Mount Isa operations nearly 12% to 2.20 million tons and recovered about 127,800 tons of lead, 31,000 tons less than in 1971. The average lead content of the ore treated was 6.9% compared with 7.2% in 1971. The lead smelter operated well below design capacity throughout the year. In June 1972 the company reported silver-lead-zinc primary ore reserves in the Mount Isa mine at 61.7 million tons averaging 4.8 ounces silver per ton, 6.9% lead, and 6.3% zinc. At the Hilton mine primary silver-lead-zinc ore reserves were estimated at 39.2 million tons averaging 5.8 ounces silver per ton, 7.7% lead, and 9.6% zinc.[9]

Broken Hill South Ltd. treated 216,200 tons of ore averaging 9.7% lead, 6.7 ounces silver per ton, and 8.5% zinc and produced 29,000 tons of lead concentrate averaging 68.7% lead, 44.7 ounces silver per ton, and 4.9% zinc. In addition, the company treated 224,100 tons of dump material assaying 2.8% lead, 3.2 ounces silver per ton, and 4.1% zinc and produced 3,230 tons of lead and 366,100 ounces of silver in lead concentrate and 5,950 tons of zinc in zinc concentrate. The lead concentrates produced by the company were sold to the Broken Hill Associated Smelters, Pty. Ltd. (BHAS) at Port Pirie. In addition to copper and zinc the company's operation at Cobar produced 3,660 tons of lead concentrate assaying 45.7% lead from the treatment of copper-zinc ore. The company closed its South mine in July after 87 years of operation.

E.Z. Industries Ltd. (Electrolytic Zinc Co. of Australia Ltd.) continued to expand production at its Rosebery mine in Tasmania. During fiscal year 1972 the company milled 473,800 tons of zinc-lead-copper ore and produced about 24,000 tons of lead concentrate, a 54% gain in ore milled

[9] M.I.M. Holdings Ltd. 1972 Annual Report. Pp. 5–6.

and a 75% gain in output of lead concentrate compared with production in fiscal year 1971. The expansion program to double production was virtually completed during the fiscal year.

Lead production at the Port Pirie smelter operated by BHAS was 207,200 tons, a gain of 18,700 tons over 1971 output attributable largely to uninterrupted operations and absence of labor strikes during the year.

At the New Broken Hill Consolidated Ltd. (NBHC) mine at Broken Hill 1.26 million tons of lead-zinc-silver ore averaging 7.9% lead, 13.6% zinc, and 2.0 ounces silver per ton was milled to produce 124,000 tons of lead concentrate containing 94,000 tons of lead, and 2.0 million ounces of silver. The gain of 7% in concentrate production reflected increased ore production due to the absence of industrial stoppages during the year and slightly higher ore grade. At the Zinc Corp. Ltd. (ZC) mine the company milled 920,000 tons of ore averaging 10.9% lead, 10.6% zinc, and 2.9 ounces silver per ton and produced 126,000 tons of lead concentrate containing 96,000 tons of lead and 2.1 million ounces of silver, virtually the same as in 1971. Estimated fully developed ore reserves in the NBHC mine at yearend were 7.28 million tons assaying 9.1% lead, 14.0% zinc, and 2.3 ounces silver per ton. In the ZC mine estimated ore reserves remained virtually unchanged at 6.83 million tons averaging 11.6% lead, 9.8% zinc, and 2.5 ounces silver per ton.

Sulphide Corp. (Pty.) Ltd. produced 30,200 tons of lead bullion at its Cockle Creek smelter, a gain of 3,400 tons over 1971 output. The company's output of zinc, sulfuric acid, and cadmium also increased in 1972.

North Broken Hill Ltd. reported that it mined 563,470 tons of ore during fiscal 1972. The ore assayed 13.0% lead, 10.0% zinc, and 6.8 ounces silver per ton, and production was 95,860 tons of lead concentrate containing 70,100 tons of lead. Ore reserves were estimated at 5.0 million tons.

Canada.—Canadian mine output of lead contained in ores and concentrates declined 3% in 1972 from the record production in 1971. The decrease in output was attributed largely to labor strikes at Cominco Ltd., and Heath Steele Mines Ltd. Mattabi Mines Ltd. began production operations in July, and Manitou-Barvue Mines Ltd., resumed production in June after an 8-month shutdown because of low metal prices. Cominco Ltd. announced the reopening of its H.B. mine in 1973 which will operate at a rate of 1,000 tons per day. Cominco also reported that underground development continued at the Cominco-Bankeno zinc-lead deposit on Little Cornwallis Island to confirm ore reserves estimated at 24 million tons averaging 24% combined lead and zinc. Nigadoo River Mines Ltd. suspended operations following a labor strike and Dresser Minerals, a division of Dresser Industries Inc., announced the closing of its lead-zinc mining operations in August.

Two Provinces, British Columbia and New Brunswick, and the Yukon and Northwest Territories together accounted for nearly 70% of Canada's total mine output of lead.

Primary lead output from refineries at Trail, British Columbia, operated by Cominco Ltd., and at Belledune, New Brunswick, operated by Brunswick Mining & Smelting Corp. Ltd. increased about 12% to 208,600 tons. Conversion of the Belledune smelter from an Imperial Smelting Process (ISP) plant to a straight lead smelter will, when completed and additional equipment installed in 1973, increase lead refining capacity about 82% to 60,000 tons per year.

Exports of lead in ores and concentrates declined 10% to 178,500 tons compared with 199,200 tons in 1971. Shipments to Japan increased, but shipments to other countries declined. Refined metal exports totaling 140,700 tons were about 3% more than in 1971. Shipments to the United States which accounted for 59% of the total increased 45%. Small increases in shipments to the United Kingdom and the Netherlands also were recorded, but shipments to other countries declined.

Heath Steele Mines Ltd., jointly owned by AMAX and International Nickel Co. of Canada Ltd. (Inco), treated 836,000 tons of lead-zinc-copper ore at its New Brunswick mill and produced 22,000 tons of lead concentrate along with zinc and copper concentrate compared with 45,000 tons in 1971. The decline in mill output was attributed to an 8-week strike and to a lower grade of ore. The company began an $11 million expansion program scheduled for completion in 1975 that will increase mine and mill production by approximately one-third and improve metallurgical recoveries.[10]

Anvil Mining Corp. Ltd. completed the third year of operation at its open pit mine and concentrator in 1972 and reported the sale of concentrate containing 103,560 tons of lead plus zinc and silver. The company reported an increase in the average concentrator throughput to nearly 8,000 tons per day with a grade of 10.8% combined lead and zinc. Ore reserves at yearend were estimated at 55 million tons averaging 8.86% combined lead and zinc with 1.1 ounces of silver per ton.

Brunswick Mining and Smelting Corp. Ltd. reported that it milled 3,257,600 tons of lead-zinc-copper ore yielding 172,900 tons of lead concentrate, 320,800 tons of zinc concentrate, and 17,600 tons of copper concentrate. An increase of 218,000 in tons treated combined with an increase in average grade of 0.27% to 9.92% combined lead and zinc resulted in a record high output of concentrate. Preliminary conversion of the zinc-lead ISP smelter to a smelter treating only lead concentrate was made in January. Additional modifications in sintering and crushing and refining facilities to increase capacity were begun in mid-October; operations were scheduled to be resumed early in 1973. Although smelter modification reduced operating time to less than 9 months, production of refined lead increased 13,560 tons to 35,980 tons. Reserves of lead-zinc ore in the No. 12 mine at yearend were estimated at 73.5 million tons averaging about 3.8% lead, 9.4% zinc, 0.27% copper, and 2.8 ounces of silver per ton.[11]

ASARCO reported that production of lead, zinc, and silver at its Buchans mine in Newfoundland was almost double 1971 output when a 21-week strike interrupted operations. Byproduct lead from the Ecstall Mining Co. Kidd Creek mine in Ontario and from United Keno Hill Mines Ltd. mine operations in the Yukon also contributed to Canada's total lead output.

Cominco Ltd., continued to operate the Sullivan mine in British Columbia, the Pine Point mine in the Northwest Territories and the Trail smelter which treated company and custom lead-zinc ores. Ore production at the Sullivan mine was 1.92 million tons with a combined lead-zinc grade of 10.8% compared with 1.98 million tons averaging 11.3% in 1971; Pine Point ore production was 3.81 million tons averaging 8.9% combined lead-zinc and yielding 119,000 tons of lead concentrate and 391,000 tons of zinc concentrate, most of which was shipped to the Trail smelter. The company began work preparatory to reopening the H.B. lead-zinc mine near Trail. The mine and concentrator, which had been closed since 1966, was scheduled for production early in 1973. Lead production at Trail from all sources totaled 170,000 tons compared with 163,000 tons in 1971. Ore reserves at the Sullivan and H.B. mines totaled 63.0 million tons containing 6.9 million tons combined zinc and lead; and Pine Point reserves totaled 41.0 million tons containing 3.4 million tons of zinc and lead.[12]

Honduras.—New York and Honduras Rosario Mining Co. reported that it treated a record tonnage of ore at its El Mochito mine and established a record production of lead, zinc, and cadmium, and only slightly less silver than in 1971. The mill processed 314,000 tons averaging 8.0% lead, 9.4% zinc, and 11.7 ounces of silver per ton and recovered lead concentrates containing 19,825 tons of lead along with silver, gold, and zinc. Assured and probable ore reserves in the main mine area at yearend were 1.94 million tons grading 10.7% lead, 11.5% zinc, 12.3 ounces of silver and 0.007 ounce of gold per ton. The 7% decrease in reserves reflected the emphasis placed on deep-level development, including shaft sinking below the 1,725 level and preparation of the new working levels and reduced amount of development for new ore. Exploration and development of the San Juan ore body have increased overall ore reserves by 2.84 million tons grading 2.7% lead, 6.9% zinc, 0.3% copper and 2.6 ounces of silver per ton. Mining of this ore body is scheduled to begin in 1974, and further expansion of milling facilities is planned to accomodate increased ore production.

India.—In 1972 Hindustan Zinc Ltd. (HZL) produced 346,500 tons of zinc-lead ore at its Zawar mine, and recovered 4,980 tons of lead concentrate, a moderate in-

---

[10] Page 17 of work cited in footnote 7.
[11] Brunswick Mining and Smelting Corp. Ltd. Twentieth Annual Report. 1972. Pp. 6–7.
[12] Cominco Ltd. 67th Annual Report. 1972, pp. 8–9.

crease over output in 1971. The concentrate was processed at the company's smelter at Tundov, Bihar, and about 2,900 tons of lead metal recovered, only 49% of the smelter's rated capacity compared with 1,700 tons in 1971. Plans to expand ore production to 2,000 tons per day announced in 1971 were not implemented.

During 1972 imports of lead totaled 43,900 tons. According to the Planning Commission India's metal availability in 1972 totaled 55,000 tons compared with estimated demand of 97,500 tons indicating a supply shortfall of 42,500 tons.

Ireland.—Tara Exploration and Development Co. Ltd. reported significant progress on the underground development of its Navan lead-zinc ore body comprising sinking an access shaft and driving a decline tunnel. Design of plant facilities advanced according to plan, and construction was scheduled to start late in 1973; initial production was scheduled to begin by mid-1975. The Navan ore body is currently estimated to contain reserves totaling 77 million tons averaging 2.62% lead and 10.99% zinc. Initial plans include a vertical three-compartment development shaft and a service tunnel declined at approximately 20%. Trackless load-haul-dump vehicles will be used, and primary crushing will take place underground. Ore will be hoisted from the mine through a production shaft from a depth of about 1,000 feet. The concentrator will have an initial design capacity of 7,500 tons per day. The annual output when the mine is in full production will amount to about 466,000 tons of concentrate containing 265,000 tons of zinc and lead in the approximate ratio of 5 to 1. The total capital cost to bring the mine into production is estimated at $85 million, representing the largest single capital investment by private industry in the Republic of Ireland.[13]

Irish Base Metals Ltd. at Tynagh milled 587,233 tons of ore, which yielded 45,200 tons of lead, 30,800 tons of zinc, and 2,050 tons of copper. Primary sulfide ore reserves at yearend were 410,000 tons, averaging 8.0% lead, 3.4% zinc, 0.7% copper, and 3.8 ounces of silver per ton.

Mexico.—ASARCO Mexicana, S.A., 49% owned by ASARCO, reported that its mines and plants operated normally during 1972, with the exception of the Chihuahua lead smelter, which continued to experience technical problems with its updraft sintering plant. The company's mine development program brought favorable results. Implementation of the expansion program at the Taxco unit advanced with the installation of new hoisting equipment and headframe, shaft sinking, and preparation of surface sites for the new mine and related facilities. The company produced 75,600 tons of lead, about 2,200 tons more than in 1971.[14]

Morocco.—Lead production in 1972 increased 11,412 tons to 97,392 tons, of which 33,600 tons came from the Zaida mine in its first full year of operation. Exports of lead rose by about 50% to 151,400 tons, most of which was shipped to France. New reserves at Touissit were estimated at 3.4 million tons averaging about 14% lead. Production is expected to begin in mid-1974.

Nicaragua.—Neptune Gold Mining Co., controlled and operated by ASARCO, achieved near-capacity production at its Vesubio lead-zinc mine during its first full year of operation. Output of lead in concentrates was 2,200 tons compared with 600 tons in 1971. The grade of ore mined from the upper levels of the mine was below the average that will be obtained when lower levels are fully developed for production.

Peru.—Cerro Corp. reported that its Cerro-Peru operations were relatively free of labor strike interruptions during 1972, which resulted in a substantial increase in output of lead, zinc, and copper at its mines and refineries. Refined lead production was nearly 94,300 tons, about 19,300 tons more than in 1971. The corporation operated six mines and related metallurgical facilities—Cobriza, Cerro de Pasco, Yauricocha, San Cristobal, Casapalca, and Morococha. The Cerro de Pasco mine, predominately a producer of lead-zinc-silver ore, treated 1.9 million tons partly from the McCune open pit and partly from underground. The Yauricocha mine treated approxiately 480,000 tons of copper-lead-silver ore at its concentrator, and the San Cristobal mine treated about 570,000 tons of copper-lead-zinc-silver ore. The Casapalca and Morococha mines treated about 600,000 and 550,000 tons of copper-lead-

[13] Tara Exploration and Development Co. Ltd. Annual Report. 1972. Pp. 3, 6–7, 9.

[14] Pages 7 and 13 of work cited in footnote 5.

zinc-silver ore, respectively. In 1972 about 47% of Cerro-Peru's refined lead production came from purchased ores, 40% came from purchased ores in 1971.

Yugoslavia.—Trepča Corp. expansion and modernization of production facilities at its Stari Trg mine continued during the year. When completed in 1975, the expansion program will increase ore production capacity to 440,000 tons per year and metal production to 184,000 tons of lead per year.

TECHNOLOGY

Most of the research and development effort in the lead industry continued to be market-oriented with emphasis on maintaining growth in established uses and in developing new applications that will offset a declining trend in some areas where substitution and environmental restrictions have become significant factors. Further progress was made in developing automotive emission control technology and equipment that will be effective in reducing lead and other exhaust pollutants in compliance with standards established under the Clean Air Act of 1970.

A dual-bed catalytic device designed by Gould, Inc., to meet auto exhaust emission control standards for carbon monoxide, hydrocarbons, and nitrogen oxides was undergoing tests by leading automobile and antiknock-additive manufacturers to determine the catalysts effectiveness and compatibility with leaded gasoline. The company stated that the first catalyst in the dual-bed system not only is effective in reducing nitrogen oxides but facilitates the action of the second oxidation catalyst which removes most of the carbon monoxide and hydrocarbons to meet emission standards.

The National Academy of Sciences (NAS) in a report to Congress and the Environmental Protection Agency stated that the Honda dual-carburated, stratified charge system, which is not sensitive to leaded gasoline, was the most promising of the five systems under evaluation by automobile manufacturers. The Honda system was reported by NAS to be clearly superior to the noble metal catalyst system. NAS also stated that the Honda system offers the promise of lower initial costs, greater durability in service, and significantly greater fuel economy compared with the catalyst system. The stratified charge engine achieved well over the 90% reduction in hydrocarbon and carbon monoxide emissions, called for in the Clean Air Act, after 50,000 miles of durability testing. Some uncertainty exists as to whether the same degree of emission control achieved in smaller engine sizes could be mass produced for larger conventional engines by 1976.

The International Lead Zinc Research Organization (ILZRO) continued to sponsor and conduct research programs on a worldwide basis with emphasis in those areas that will have a strong impact on markets. The shortage and steeply rising price of lumber coupled with increasing labor costs has prompted strong efforts by ILZRO to produce lower cost prefabricated all-metal housing units in which lead and zinc will have major roles. The ILZRO house is designed to provide a basic moderately priced core unit that can be expanded as required, and will include such new developments as lead-plastic composites and lead sheet for sound attenuation in conjunction with galvanized steel building panels and wrought zinc roofing systems. ILZRO in cooperation with the lead battery industry has augmented research efforts to improve and increase the efficiency and power density of the lead-acid battery as a source of electrical energy for general use in addition to its primary use in automotive vehicles, particularly in response to demands of environmentalists for a totally nonpolluting vehicle.

A comprehensive study of battery manufacturing process fundamentals, sponsored by ILZRO, identified the conditions for casting calcium-lead grids in top-filled molds, using a reducing gas to prevent loss of calcium by oxidation. Battery manufacturers report that tests by auto companies indicate that maintenance-free, calcium-lead batteries may last 50,000 miles and they require no water and are permanently sealed. They can be placed out of the way to make room under the hood for pollution control devices. ILZRO participated in research directed to designing and constructing a prototype electric delivery truck powered by lead-acid batteries. Road tests indicated that operation of the battery-powered delivery vehicle under typical multistop, limited range and speed conditions was technically feasible. ILZRO also reported the development of lead-plastic composite materials combining light weight, corrosion resistance, and ease of forming suitable for such applications as fuel containers and military packaging.

The lead and zinc industry continued to sponsor extensive research into the medical, biological, and environmental aspects of these metals. A cooperative research study on the effect of airborne lead, the Seven-Cities Survey, was sponsored by the American Petroleum Institute and the Environmental Protection Agency. The data collected in this project disclosed that within the range of air-lead concentrations found in the major U.S. cities, airborne lead has no effect on the blood-lead level of the population. This finding was an important factor in the decision to defer implementation of proposed restrictions on the use of lead in gasoline. An ILZRO-sponsored project to determine the possible role lead plays in biological processes also was begun. The project may provide further conclusive data on the human health aspects of lead.

The NAS also reviewed the scientific knowledge on the biologic effects of lead on human health and welfare and issued an evaluation report [15] to help guide EPA decisions on establishing air-quality criteria. NAS concluded that the average lead content of the air over most major cities apparently has not changed greatly over the last 15 years and that little change in the character and magnitude of the effects of atmospheric lead on biologic systems will likely occur for some years to come. The NAS study also found the transfer of lead from the atmosphere to the soil is directly related to the density of automobile traffic with heavy contamination in cities and major roadways and little evidence of contamination in rural areas attributable to lead alkyls. Similarly, the waters of streams and lakes have about the same concentration of lead today as in 1940. Furthermore, there was no evidence to indicate that the amount of lead in diets of people has changed substantially since 1940.

Lead Industries Association, Inc., reported that a group of 55 electric utilities provided new stimulus to battery-powered electric vehicle production by funding a $1 million research program to purchase 100 on-the-road vehicles for practical testing. The program was sponsored by the Electric Vehicle Council (EVC), an affiliate of the Electric Energy Association, New York. The Battronic Corp. division of Boyerton Auto Body Works, Boyerton, Pa., will build the trucks designed as general purpose multistop work vehicles. The trucks will carry a 1,000-pound payload in a 140-cubic-foot cargo space.

Road tests by Toyo Kogyo Co. (Mazda) of a battery-powered delivery truck disclosed that the vehicle was capable of traveling 54 miles on one charge of its lead-zinc batteries and can attain a maximum speed of 44.5 miles per hour.

Considerable research effort was directed by members of the Battery Council International (BCI) to develop faster charging methods for run-down batteries to meet requirements of electric vehicle manufacturers. The Gel electrolyte battery described by Gould, Inc., is safer for handling than conventional wet-charge and dry-charge batteries because the acid is gelled; it is maintenance-free (never needs water) and able to operate in any position, but its capacity is reduced by the gelled electrolyte.

The Bureau of Mines Metallurgy Research Center at Reno, Nev., reported significant progress in developing a hydrometallurgical process for recovering lead and zinc from flotation concentrates by dissolution with chlorine. Extractions of 99% were obtained in preliminary tests by reaction with aqueous chlorine. Metal ions were recovered from pregnant solution by selective precipitation techniques. Progress also was reported by the Bureau investigators at Rolla, Mo., on developing new technology for the recovery of lead from galena, to replace the present sintering and blast furnace reduction with simpler, nonpolluting metallurgy that permits the recovery of elemental sulfur rather than SO_2. The new technology uses vapor phase techniques and hydrogen reduction; metallurgical recovery of at least 98% was

[15] National Academy of Sciences. Lead—Airborne Lead in Perspective. Washington, D. C. 1972, 330 pp.

achieved and metallic lead of 99.9% purity was produced. Other Bureau of Mines investigations included strengthening lead-antimony alloys by modified rolling techniques, improving fatigue resistance of lead and lead alloys by surface coatings, and developing lead composites for noise control.

Table 3.—Mine production of recoverable lead in the United States, by State

(Short tons)

State	1968	1969	1970	1971	1972
Alaska	W	2	--	--	--
Arizona	1,704	217	285	859	1,763
California	4,001	2,518	1,772	2,284	1,153
Colorado	19,778	21,767	21,855	25,746	31,346
Idaho	54,790	65,597	61,211	66,610	61,407
Illinois	1,467	791	1,532	1,238	1,335
Kansas	1,227	395	80	--	--
Kentucky	W	--	--	--	--
Maine	--	--	--	--	85
Missouri	212,611	355,452	421,764	429,634	489,397
Montana	1,870	1,753	996	615	287
Nevada	863	1,420	364	111	(1)
New Mexico	1,363	2,368	3,550	2,971	3,582
New York	1,396	1,686	1,280	877	1,089
Oklahoma	2,387	605	797	--	--
Oregon	W	(1)	(1)	--	--
South Dakota	--	1	3	--	--
Utah	45,205	41,332	45,377	38,270	20,706
Virginia	3,573	3,358	3,356	3,386	3,441
Washington	5,655	8,649	6,784	5,177	2,567
Wisconsin	1,126	1,102	761	752	757
Other States	140	--	--	20	--
Total	359,156	509,013	571,767	578,550	618,915

W Withheld to avoid disclosing individual company confidential data; included in "Other States."
[1] Less than ½ unit.

Table 4.—Production of lead and zinc in the United States in 1972, by State and class of ore, from old tailings, etc., in terms of recoverable metal

(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	--	--	--	--	--	--	(1)	(1)	(1)
California	--	--	--	[2] 14,560	[2] 553	[2] 1,010	2,817	600	192
Colorado	--	--	--	249,098	3,183	25,456	509,694	16,721	25,350
Idaho	256,793	25,237	2,273	--	--	--	683,401	35,166	35,821
Maine	--	--	--	50,850	85	3,783	--	--	--
Missouri	8,485,769	489,397	61,923	--	--	--	--	--	--
Montana	119	19	--	--	--	--	--	--	--
Nevada	--	--	--	--	--	--	--	--	--
New Jersey	--	--	--	210,768	--	38,096	--	--	--
New Mexico	--	--	--	--	--	--	138,273	3,571	12,421
New York	--	--	--	852,453	1,089	60,749	--	--	--
Pennsylvania	--	--	--	435,277	--	18,344	--	--	--
Tennessee	--	--	--	3,522,626	--	96,433	--	--	--
Utah	--	--	--	--	--	--	191,119	17,175	21,264
Virginia	--	--	--	638,929	3,441	16,789	--	--	--
Washington	--	--	--	--	--	--	217,383	2,566	6,483
Wisconsin	--	--	--	293,465	757	6,873	--	--	--
Other States	--	--	--	218,867	644	6,907	--	--	--
Total	8,742,681	514,653	64,196	6,486,893	9,752	274,440	1,742,687	75,799	101,531
Percent of total lead-zinc	--	83	14	--	2	57	--	12	21

Table 4.—Production of lead and zinc in the United States in 1972, by State and class of ore, from old tailings, etc., in terms of recoverable metal—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	[1] 100,172	[1] 667	[1] 10,071	53,194,607	1,096	40	53,294,779	1,763	10,111
California	--	--	--	(2)	(2)	(2)	17,377	1,153	1,202
Colorado	401,646	9,594	11,481	112,568	1,848	1,514	1,273,006	31,346	63,801
Idaho	--	--	--	331,046	1,004	553	1,271,240	61,407	38,647
Maine	107,952	--	2,037	--	--	--	158,802	85	5,820
Missouri	--	--	--	--	--	--	8,485,769	489,397	61,923
Montana	--	--	--	13,323	268	12	13,442	287	12
Nevada	--	--	--	159	(4)	--	159	(4)	--
New Jersey	--	--	--	--	--	--	210,768	--	38,096
New Mexico	--	--	--	2,176,670	11	314	2,314,943	3,582	12,735
New York	--	--	--	--	--	--	852,453	1,089	60,749
Pennsylvania	--	--	--	--	--	--	435,277	--	18,344
Tennessee	1,762,000	--	5,289	--	--	--	5,284,626	--	101,722
Utah	114,604	3,531	589	--	--	--	305,723	20,706	21,853
Virginia	--	--	--	--	--	--	638,929	3,441	16,789
Washington	--	--	--	66,131	1	--	283,514	2,567	6,483
Wisconsin	--	--	--	--	--	--	293,465	757	6,873
Other States	--	--	--	228,922	691	6,251	447,789	1,335	13,158
Total	2,486,374	13,792	29,467	56,123,426	4,919	8,684	75,582,061	618,915	478,318
Percent of total lead-zinc	--	2	6	--	1	2	--	100	100

[1] Lead-zinc and copper-lead, copper-zinc, and copper-lead-zinc ores combined to avoid disclosing individual company confidential data.
[2] Zinc ore and ore from "Other sources" combined to avoid disclosing individual company confidential data.
[3] Lead and zinc recovered from copper, gold, silver, and fluorspar ores, and from mill tailings and miscellaneous cleanups.
[4] Less than ½ unit.

Table 5.—Mine production of recoverable lead in the United States, by month

(Short tons)

Month	1971	1972	Month	1971	1972
January	45,171	48,849	August	48,171	56,866
February	41,875	53,302	September	51,020	50,654
March	52,848	55,645	October	48,717	51,625
April	47,615	52,177	November	49,263	46,540
May	45,994	54,093	December	56,099	45,365
June	46,101	51,153			
July	45,676	52,646	Total	578,550	618,915

Table 6.—Twenty-five leading lead-producing mines in the United States in 1972, in order of output

Rank	Mine	County and State	Operator	Source of lead
1	Buick	Iron, Mo	AMAX Lead Co. of Missouri.	Lead ore.
2	Fletcher	Reynolds, Mo	St. Joe Minerals Corp	Do.
3	Magmont	Iron, Mo	Cominco American, Inc	Do.
4	Ozark	Reynolds, Mo	Ozark Lead Co	Do.
5	Viburnum No. 29	Washington, Mo	St. Joe Minerals Corp	Do.
6	Federal	St. Francois, 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	Burgin	Utah, Utah	Kennecott Copper Corp	Lead-zinc ore.
11	Viburnum No. 27	Crawford, Mo	St. Joe Minerals Corp	Lead ore.
12	Star Morning	Shoshone, Idaho	Hecla Mining Co	Lead-zinc ore.
13	Indian Creek No. 32	Washington, Mo	St. Joe Minerals Corp	Lead ore.
14	Idarado	Ouray and San Miguel, Colo.	Idarado Mining Co	Copper-lead-zinc ore.
15	Leadville	Lake, Colo	American Smelting and Refining Co.	Lead-zinc and lead-zinc-copper ores.
16	Dayrock	Shoshone, Idaho	Day Mines, Inc	Lead ore.
17	Indian Creek No. 23	Washington, Mo	St. Joe Minerals Corp	Do.
18	Sunnyside	San Juan, Colo	Standard Metals Corp	Lead-zinc ore.
19	Camp Bird	Ouray, Colo	Federal Resources Corp	Do.
20	Ground Hog	Grant, N. Mex	American Smelting and Refining Co.	Do.
21	Mayflower	Wasatch, Utah	Hecla Mining Co	Copper-lead ore.
22	Austinville and Ivanhoe.	Wythe, Va	The New Jersey Zinc Co	Zinc ore.
23	Eagle	Eagle, Colo	do	Do.
24	Pend Oreille	Pend Oreille, Wash	Pend Oreille Mines and Metals Co.	Lead-zinc ore.
25	Bulldog Mountain	Mineral, Colo	Homestake Mining Co	Silver ore.

Table 7.—Refined lead produced at primary refineries in the United States, by source material

(Short tons)

	1968	1969	1970	1971	1972
From primary sources:					
Domestic ores and base bullion	349,039	513,931	528,086	573,022	592,658
Foreign ores and base bullion	118,271	124,724	138,644	76,993	103,001
Total	467,310	638,655	666,730	650,015	695,659
From secondary sources	2,259	4,966	4,367	1,223	1,189
Grand total	469,569	643,621	671,097	651,238	696,848
Calculated value of primary refined lead thousands[1]	$123,463	$190,702	$209,220	$180,574	$209,115

[1] Value based on average quoted price, New York, and excludes value of refined lead produced from scrap at primary refineries.

Table 8.—Antimonial lead produced at primary lead refineries in the United States

Year	Production (short tons)	Antimony content		Lead content by difference (short tons)			
		Quantity (short tons)	%	From domestic ore	From foreign ore	From scrap	Total
1968	28,363	2,007	7.1	15,788	3,706	6,862	26,356
1969	24,741	2,082	8.4	11,507	4,743	6,409	22,659
1970	20,438	1,184	5.8	8,826	2,829	7,599	19,254
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

Table 9.—Stocks and consumption of new and old lead scrap in the United States in 1972

(Short tons, gross weight)

Class of consumer and type of scrap	Stocks Jan. 1 [r]	Receipts	Consumption			Stocks Dec. 31
			New scrap	Old scrap	Total	
Smelters and refiners:						
Soft lead	5,373	43,641	--	46,632	46,632	2,382
Hard lead	3,418	24,959	--	27,619	27,619	758
Cable lead	1,123	27,236	--	26,739	26,739	1,620
Battery-lead plates	40,447	508,710	--	509,857	509,857	39,300
Mixed common babbitt	301	4,125	--	4,124	4,124	302
Solder and tinny lead	289	9,979	--	9,815	9,815	453
Type metals	2,125	23,957	--	23,690	23,690	2,392
Drosses and residues	20,411	157,508	158,881	--	158,881	19,038
Total	73,487	800,115	158,881	648,476	807,357	66,245
Foundries and other manufacturers:						
Soft lead	31	5	--	36	36	--
Hard lead	14	8	--	22	22	--
Cable lead	15	30	--	36	36	9
Battery-lead plates	--	1	--	1	1	--
Mixed common babbitt	51	6,891	--	6,925	6,925	17
Total	111	6,935	--	7,020	7,020	26
All consumers:						
Soft lead	5,404	43,646	--	46,668	46,668	2,382
Hard lead	3,432	24,967	--	27,641	27,641	758
Cable lead	1,138	27,266	--	26,775	26,775	1,629
Battery-lead plates	40,447	508,711	--	509,858	509,858	39,300
Mixed common babbitt	352	11,016	--	11,049	11,049	319
Solder and tinny lead	289	9,979	--	9,815	9,815	453
Type metals	2,125	23,957	--	23,690	23,690	2,392
Drosses and residues	20,411	157,508	158,881	--	158,881	19,038
Grand total	73,598	807,050	158,881	655,496	814,377	66,271

[r] Revised.

Table 10.—Secondary metal recovered[1] from lead and tin scrap in the United States in 1972, by type of product

(Short tons, gross weight)

	Lead	Tin	Antimony	Other	Total
Refined pig lead	150,142	--	--	--	150,142
Remelt lead	23,215	--	--	--	23,215
Total	173,357	--	--	--	173,357
Refined pig tin	--	2,251	--	--	2,251
Remelt tin	--	212	--	--	212
Total	--	2,463	--	--	2,463
Lead and tin alloys:					
Antimonial lead	345,882	676	17,452	448	364,458
Common babbitt	13,791	799	1,241	22	15,853
Genuine babbitt	19	157	6	5	187
Solder	33,648	5,838	684	90	40,260
Type metals	23,456	1,379	3,008	1	27,844
Cable lead	11,798	--	28	--	11,826
Miscellaneous alloys	626	90	9	23	748
Total	429,220	8,939	22,428	589	461,176
Tin content of chemical products	--	802	--	--	802
Grand total	602,577	12,204	22,428	589	637,798

[1] Most of the figures herein represent actual reported recovery of metal from scrap.

Table 11.—Secondary lead recovered in the United States

(Short tons)

	1968	1969	1970	1971	1972
As metal:					
At primary plants	2,259	4,966	4,367	1,223	1,189
At other plants	136,607	149,344	154,800	148,911	172,168
Total	138,866	154,310	159,167	150,134	173,357
In antimonial lead:					
At primary plants	6,862	6,409	7,599	2,379	5,816
At other plants	301,701	336,066	340,759	340,333	340,066
Total	308,563	342,475	348,358	342,712	345,882
In other alloys	103,450	107,120	89,865	103,951	97,358
Grand total:					
Quantity	550,879	603,905	597,390	596,797	616,597
Value thousands[1]	$145,542	$180,326	$187,461	$165,790	$185,349

[1] Values for 1968–71 based on average price quotation at New York, and for 1972 on a nationwide delivered basis.

Table 12.—Lead recovered from scrap processed in the United States, by kind of scrap and form of recovery

(Short tons)

Kind of scrap	1971	1972	Form of recovery	1971	1972
New scrap:			As soft lead:		
Lead-base	102,693	113,795	At primary plants	1,223	1,189
Copper-base	3,859	4,669	At other plants	148,911	172,168
Tin-base	464	421	Total	150,134	173,357
Total	107,016	118,885	In antimonial lead[1]	342,712	345,882
Old scrap:			In other lead alloys	88,053	82,725
Battery-lead plates	333,007	347,881	In copper-base alloys	15,858	14,614
All other lead-base	142,239	134,209	In tin-base alloys	40	19
Copper-base	14,532	15,620			
Tin-base	3	2	Total	446,663	443,240
Total	489,781	497,712	Grand total	596,797	616,597
Grand total	596,797	616,597			

[1] Includes 2,379 tons of lead recovered in antimonial lead from secondary sources at primary plants in 1971 and 5,816 in 1972.

Table 13.—Lead consumption in the United States, by product

(Short tons)

Product	1971	1972	Product	1971	1972
Metal products:			Pigments—Continued:		
Ammunition	87,567	84,699	Pigment colors	13,916	16,264
Bearing metals	16,285	15,915	Other [1]	773	337
Brass and bronze	20,044	19,805			
Cable covering	52,920	45,930	Total	81,258	89,214
Calking lead	29,993	22,483			
Casting metals	7,281	7,139	Chemicals:		
Collapsible tubes	10,041	4,020	Gasoline antiknock additives	264,240	278,340
Foil	4,417	4,592	Miscellaneous chemicals	401	849
Pipes, traps, and bends	18,174	17,780			
Sheet lead	27,607	23,667	Total	264,641	279,189
Solder	70,013	71,289			
Storage batteries:			Miscellaneous uses:		
Battery grids, posts, etc.	322,236	347,225	Annealing	4,068	4,329
Battery oxides	357,567	379,367	Galvanizing	1,395	1,397
Terne metal	1,409	504	Lead plating	582	638
Type metal	20,812	19,944	Weights and ballast	17,453	21,302
Total	1,046,366	1,064,359	Total	23,498	27,666
Pigments:			Other, unclassified uses	15,751	24,826
White lead	4,731	2,814			
Red lead and litharge	61,838	69,799	Grand total [2]	1,431,514	1,485,254

[1] Includes lead content of leaded zinc oxide and other pigments.
[2] Includes lead that went directly from scrap to fabricated products.

Table 14.—Lead consumption in the United States, by month

(Short tons)

Month	1971	1972	Month	1971	1972
January	118,676	122,272	August	123,174	127,368
February	113,197	123,671	September	130,568	125,984
March	126,579	132,311	October	127,763	132,241
April	120,660	122,367	November	121,126	131,438
May	120,104	129,012	December	117,346	120,500
June	116,548	126,651			
July	95,773	91,439	Total [1]	1,431,514	1,485,254

[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 1972, 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	175,116	81,924	66,520	14,207	337,767
Storage batteries	390,728	335,864	--	--	726,592
Pigments	89,214	--	--	--	89,214
Chemicals	278,890	299	--	--	279,189
Miscellaneous	13,398	14,216	52	--	27,666
Unclassified	23,092	906	828	--	24,826
Total	970,438	433,209	67,400	14,207	[1] 1,485,254

[1] Includes lead that went directly from scrap to fabricated products and lead contained in leaded zinc oxide and other pigments.

Table 16.—Lead consumption in the United States in 1972, by State [1]

(Short tons)

State	Refined soft lead	Lead in antimonial lead	Lead in alloys	Lead in copper-base scrap	Total
California	90,682	38,132	7,421	783	137,018
Colorado	1,042	3,345	65	--	4,452
Connecticut	10,579	10,079	7	1,336	22,001
District of Columbia	114	--	--	--	114
Florida	5,751	9,102	--	--	14,853
Georgia	55,810	20,382	480	--	76,672
Illinois	87,616	54,148	10,735	2,095	154,594
Indiana	99,403	47,502	3,454	444	150,803
Kansas	11,104	10,075	49	174	21,402
Kentucky	6,017	12,398	1	--	18,416
Maryland	1,042	11,206	3,154	14	15,416
Massachusetts	2,219	781	21	300	3,321
Michigan	14,597	18,335	2,432	279	35,643
Missouri	32,032	10,226	1,494	704	44,456
Nebraska	3,186	1,001	1,337	1,105	6,629
New Jersey	134,018	20,600	7,449	706	162,773
New York	45,905	1,430	9,778	423	57,536
Ohio	12,089	3,407	9,069	1,497	26,062
Pennsylvania	61,056	41,113	4,989	2,370	109,528
Rhode Island	1,481	567	--	--	2,048
Tennessee	7,244	18,134	244	149	25,771
Virginia	644	1,967	1,171	471	4,253
Washington	15,479	563	115	--	16,157
West Virginia	17,301	578	--	--	17,879
Wisconsin	5,281	8,287	26	373	13,967
Alabama and Mississippi	4,634	5,716	--	463	10,813
Arkansas and Oklahoma	5,742	3,304	97	--	9,143
Hawaii and Oregon	4,682	8,223	--	--	12,905
Iowa and Minnesota	4,426	15,142	1,489	--	21,057
Louisiana and Texas	211,962	37,693	2,223	391	252,269
Montana and Idaho	697	--	--	--	697
New Hampshire, Maine, Vermont, Delaware	11,583	13,834	100	130	25,647
North and South Carolina	4,985	5,939	--	--	10,924
Utah, Nevada, Arizona	35	--	--	--	35
Total	970,438	433,209	67,400	14,207	1,485,254

[1] Includes lead that went directly from scrap to fabricated products and lead contained in leaded zinc oxide and other pigments.

Table 17.—Production and shipments of lead pigments [1] and oxides in the United States

Product	1971				1972			
	Production (short tons)	Shipments			Production (short tons)	Shipments		
		Quantity (short tons)	Value [2]			Quantity (short tons)	Value [2]	
			Total	Average per ton			Total	Average per ton
White lead:								
Dry	7,505	5,466	$2,348,721	$430	7,811	9,728	$4,466,278	$459
In oil [3]	1,297	1,315	868,893	661	304	338	230,201	681
Total	8,802	6,781	3,217,614	474	8,115	10,066	4,696,479	467
Red lead	23,548	20,989	7,587,104	361	24,168	19,773	7,266,019	367
Litharge	138,271	147,844	46,301,521	313	139,800	147,622	49,160,732	333
Black oxide	283,032	--	--	--	306,689	--	--	--

[1] Excludes basic lead sulfate, figures withheld to avoid disclosing individual company confidential data.
[2] At plant, exclusive of container.
[3] Weight of white lead only, but value of paste.

Table 18.—Lead content of lead and zinc pigments[1] and lead oxides produced by domestic manufacturers, by source

(Short tons)

Product	1971 Lead in pigments produced from— Ore Domestic	1971 Ore Foreign	1971 Pig lead	1971 Total lead in pigments	1972 Lead in pigments produced from— Ore Domestic	1972 Ore Foreign	1972 Pig lead	1972 Total lead in pigments
White lead	--	--	7,042	7,042	--	--	6,492	6,492
Red lead	--	--	21,346	21,346	--	--	21,908	21,908
Litharge	--	--	128,592	128,592	--	--	130,014	130,014
Black oxide	--	--	270,097	270,097	--	--	292,492	292,492
Leaded zinc oxide	W	W	--	W	W	W	--	W
Total	W	W	427,077	427,077	W	W	450,906	450,906

W Withheld to avoid disclosing individual company confidential data.
[1] Excludes lead in basic lead sulfate.

Table 19.—Distribution of white lead (dry and in oil) shipments,[1] by industry

(Short tons)

Industry	1968	1969	1970	1971	1972
Paints	6,681	5,969	4,460	4,396	6,768
Ceramics	124	67	26	34	31
Other	4,829	4,323	4,152	2,351	3,267
Total	11,634	10,359	8,638	6,781	10,066

[1] Excludes basic lead sulfate (figures withheld to avoid disclosing individual company confidential data).

Table 20.—Distribution of red lead shipments, by industry

(Short tons)

Industry	1968	1969	1970	1971	1972
Paints	11,347	9,191	7,848	8,717	4,909
Storage batteries	W	9,302	W	W	W
Other	12,464	3,684	11,596	12,272	14,864
Total	23,811	22,177	19,444	20,989	19,773

W Withheld to avoid disclosing individual company confidential data; included with "Other."

Table 21.—Distribution of litharge shipments, by industry

(Short tons)

Industry	1968	1969	1970	1971	1972
Ceramics	24,123	21,570	24,578	24,337	23,188
Insecticides	W	W	W	W	W
Oil refining	1,849	1,603	2,016	1,413	1,262
Paints	1,787	1,511	1,315	3,085	7,316
Rubber	1,986	1,794	1,663	2,081	2,162
Other	r 101,433	r 109,241	r 116,771	r 116,928	113,694
Total	131,178	135,719	146,343	147,844	147,622

r Revised.
W Withheld to avoid disclosing individual company confidential data; included with "Other."

Table 22.—U.S. imports for consumption of lead pigments and compounds

Kind	1971		1972	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
White lead	1,231	$379	600	$216
Red lead	4,899	1,134	1,289	377
Litharge	14,704	2,940	15,358	4,147
Chrome yellow	6,224	2,913	7,530	3,809
Other lead pigments	202	56	1,348	490
Other lead compounds	633	225	425	205
Total	r 27,893	7,647	26,550	9,244

r Revised.

Table 23.—Stocks of lead at primary smelters and refineries in the United States, December 31

(Short tons)

Stocks	1968	1969	1970	1971	1972
Refined pig lead	11,490	21,283	90,866	46,762	60,840
Lead in antimonial lead	3,852	4,448	6,988	5,318	3,626
Lead in base bullion	11,471	12,726	11,710	13,803	11,514
Lead in ore and matte	63,614	63,403	83,421	55,777	69,593
Total	90,427	101,860	192,985	121,660	145,573

Table 24.—Consumer stocks of lead in the United States, December 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
1968	43,933	25,009	9,184	774	78,900
1969	67,304	49,649	8,506	945	126,404
1970	82,823	42,420	7,344	915	133,502
1971	81,934	35,700	6,979	964	125,577
1972	74,161	36,157	6,977	1,249	118,544

Table 25.—Average monthly and yearly quoted prices of lead

(Cents per pound)

Month	1971 [1]			1972 [2]	
	St. Louis	New York	London	U.S. producer	London Metal Exchange
January	13.30	13.50	11.92	14.00	11.40
February	13.30	13.50	12.14	14.60	13.33
March	13.30	13.50	12.21	15.50	14.51
April	13.30	13.50	12.23	15.57	14.32
May	13.30	13.50	12.08	15.60	14.40
June	13.50	13.70	12.11	15.50	14.10
July	14.05	14.25	11.96	15.50	13.77
August	14.05	14.25	11.71	15.41	13.50
September	14.05	14.25	10.83	15.00	13.71
October	14.05	14.25	10.39	14.67	13.46
November	14.05	14.25	10.04	14.50	13.48
December	--	14.19	10.47	14.50	13.98
Average	[3] 13.66	13.89	11.52	15.03	13.68

[1] St. Louis: Metal Statistics, 1972. New York: Metal Statistics, 1972. London: Metals Week.
[2] Metals Week. Quotations for United States on a nationwide, delivered basis.
[3] Eleven-month average.

Table 26.—U.S. exports of lead, by country [1]

Destination	1971 Quantity (short tons)	1971 Value (thousands)	1972 Quantity (short tons)	1972 Value (thousands)
Unwrought lead and lead alloys:				
Belgium-Luxembourg	2	$1	755	$314
Brazil	--	--	28	7
Canada	911	340	553	265
Chile	10	3	1	1
Dominican Republic	41	18	14	6
Honduras	--	--	56	25
Hong Kong	--	--	21	16
Italy	2	1	3,203	897
Jamaica	17	6	5	2
Japan	612	177	30	24
Korea, Republic of	5	3	1	3
Mexico	83	36	338	115
Netherlands	8	7	958	426
Paraguay	--	--	51	18
Philippines	74	44	35	54
Spain	12	6	106	11
Sweden	221	169	--	--
Taiwan	1,102	301	20	18
Thailand	220	56	--	--
United Kingdom	46	31	34	18
Venezuela	21	23	306	179
Vietnam, South	186	56	--	--
Other	196	117	90	61
Total	3,769	1,395	6,605	2,460
Wrought lead and lead alloys:				
Australia	10	9	28	36
Belgium-Luxembourg	6	7	25	24
Canada	229	219	282	246
Chile	111	86	34	39
Colombia	86	44	13	8
Dominican Republic	129	70	39	58
France	19	19	37	42
Germany, West	32	27	14	16
Italy	38	38	42	34
Jamaica	121	108	27	28
Japan	96	162	114	130
Korea, Republic of	83	20	--	--
Mexico	43	42	102	106
Netherlands	433	982	301	584
Pakistan	3	2	(2)	1
Philippines	66	39	20	15
Spain	(2)	1	16	45
Sweden	44	38	67	59
Taiwan	32	30	51	62
Turkey	2	3	12	7
United Kingdom	61	81	131	99
Venezuela	143	99	125	105
Other	369	368	291	296
Total	2,156	2,494	1,771	2,040
Scrap:				
Belgium-Luxembourg	1,131	188	193	41
Brazil	169	20	445	69
Canada	r 12,370	r 1,558	27,123	2,828
Germany, West	1,099	183	1,809	200
Italy	749	82	42	11
Japan	337	32	1,474	256
Netherlands	456	51	2,441	579
Philippines	218	28	3	1
South Africa, Republic of	53	7	--	--
Spain	--	--	109	19
Trinidad and Tobago	--	--	101	10
United Kingdom	429	95	220	61
Venezuela	--	--	1,205	180
Other	80	24	68	9
Total	r 17,091	r 2,268	35,233	4,264
Grand total	23,016	6,157	43,609	8,764

r Revised.
[1] In addition foreign lead was reexported as follows: Unwrought lead and lead alloys 1971, 8 tons ($2,724); 1972, none. Wrought lead and lead alloys 1971, 23 tons ($9,224); 1972, 3 tons ($12,943); scrap 251 tons ($24,054).
[2] Less than ½ unit.

Table 27.—U.S. imports [1] of lead, by country

Country	1970 Quantity (short tons)	1970 Value (thousands)	1971 Quantity (short tons)	1971 Value (thousands)	1972 Quantity (short tons)	1972 Value (thousands)
Ore, flue dust, and matte, (lead content):						
Argentina	31	$5	227	$42	9	$2
Australia	29,360	6,468	8,893	1,656	20,722	4,350
Belgium-Luxembourg	--	--	--	--	13	4
Bolivia	3,041	561	--	--	--	--
Canada	41,337	9,223	21,885	4,217	30,338	6,370
Colombia	464	62	211	42	216	48
Guatemala	68	13	1,075	93	--	--
Honduras	15,054	2,539	15,121	1,543	17,790	2,543
Mexico	440	101	146	27	1,181	199
Nicaragua	--	--	--	--	3,329	537
Peru	21,337	5,117	18,393	3,579	27,820	6,021
Other	1,274	246	47	53	96	20
Total	112,406	24,335	65,998	11,252	101,514	20,094
Base bullion (lead content):						
Canada	--	--	--	--	895	238
Mexico	170	40	14	4	--	--
United Kingdom	126	93	27	12	--	--
Total	296	133	41	16	895	238
Pigs and bars (lead content):						
Australia	51,705	13,902	46,044	10,107	35,638	8,677
Belgium-Luxembourg	680	396	153	100	2,903	822
Burma	341	132	--	--	186	46
Canada	63,753	19,107	56,821	14,015	82,816	22,234
Denmark	140	64	281	119	843	331
France	1,255	357	--	--	123	45
Germany:						
East	--	--	--	--	1,102	265
West	703	2,037	173	411	1,445	513
Mexico	38,368	10,156	29,645	6,725	35,513	8,069
Netherlands	174	150	198	75	2,292	693
Peru	52,473	16,292	36,372	9,500	49,260	13,320
South Africa, Republic of	12,984	4,164	13,519	4,083	8,804	2,698
Switzerland	--	--	--	--	7,994	2,067
United Kingdom	2,928	1,508	3,677	1,227	11,777	3,160
Yugoslavia	18,765	4,930	8,704	2,258	1,651	460
Other	354	202	--	--	43	45
Total	244,623	73,397	195,587	48,620	242,390	63,445
Reclaimed scrap, etc. (lead content):						
Australia	3,638	1,098	1,741	423	2,472	559
Austria	--	--	100	27	--	--
Bahamas	2	(2)	1	1	32	4
Canada	2,075	661	889	228	356	101
Dominican Republic	--	--	--	--	42	11
Mexico	1,056	141	642	85	282	42
Panama	84	21	--	--	--	--
United Kingdom	--	--	--	--	51	19
Other	r 2	(2)	r 10	1	--	--
Total	6,857	1,921	3,383	765	3,235	736
Grand total	364,182	99,786	265,009	60,653	348,034	84,513

r Revised.
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	1970 Quantity (short tons)	1970 Value (thousands)	1971 Quantity (short tons)	1971 Value (thousands)	1972 Quantity (short tons)	1972 Value (thousands)
Ore, flue dust, and matte, (lead content):						
Argentina	31	$5	290	$57	27	$7
Australia	6,726	1,539	11,382	2,538	12,887	3,150
Belgium-Luxembourg	--	--	--	--	13	4
Bolivia	1,914	358	9	(2)	--	--
Canada	23,436	4,474	36,406	8,209	14,794	3,263
Colombia	301	19	227	43	234	41
Honduras	1,087	192	18,803	3,798	8,300	1,213
Mexico	121	23	385	57	3,432	270
Morocco	12	3	42	14	41	9
Peru	8,228	1,595	20,634	4,607	11,910	2,596
Other	750	152	6	39	4	1
Total	42,606	8,360	88,184	19,362	51,642	10,554
Base bullion (lead content):						
Australia	876	238	--	--	--	--
Canada	--	--	--	--	895	238
Mexico	175	117	14	4	--	--
United Kingdom	126	93	27	12	--	--
Total	1,177	448	41	16	895	238
Pigs and bars (lead content):						
Australia	51,705	13,902	43,045	9,512	38,637	9,272
Belgium-Luxembourg	680	396	153	100	2,903	822
Burma	341	132	--	--	186	46
Canada	63,753	19,107	56,820	14,015	83,008	22,285
Denmark	140	64	281	119	843	331
France	1,255	357	--	--	123	45
Germany:						
East	--	--	--	--	1,102	265
West	703	2,037	173	411	1,445	513
Mexico	38,368	10,156	29,645	6,725	35,513	8,069
Netherlands	174	150	198	75	2,292	693
Peru	52,473	16,292	36,372	9,500	49,260	13,320
South Africa, Republic of	12,984	4,164	13,519	4,083	8,804	2,698
Switzerland	--	--	--	--	7,994	2,067
United Kingdom	2,928	1,508	3,660	1,223	11,794	3,165
Yugoslavia	18,765	4,930	8,704	2,258	1,651	460
Other	354	202	--	--	43	45
Total	244,623	73,397	192,570	48,021	245,598	64,096
Reclaimed scrap, etc. (lead content):						
Australia	352	116	976	264	990	273
Bahamas	2	(2)	1	1	32	4
Canada	1,394	495	889	228	356	101
Dominican Republic	--	--	--	--	42	11
Mexico	1,056	141	642	85	282	42
Netherlands Antilles	19	4	--	--	--	--
Panama	84	21	--	--	--	--
Spain	37	11	--	--	--	--
United Kingdom	23	7	--	--	51	19
Other	14	3	10	1	--	--
Total	2,981	798	2,518	579	1,753	450
Sheets, pipe, and shot:						
Belgium-Luxembourg	45	17	20	8	25	10
Canada	320	169	82	37	8	4
Mexico	--	--	--	--	1	1
Netherlands	87	33	73	23	44	15
United Kingdom	35	13	62	18	34	14
Yugoslavia	26	9	--	--	30	8
Total	513	241	237	86	142	52
Grand total	291,900	83,244	283,550	68,064	300,030	75,390

[1] Excludes imports for refining and export, 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	Lead in ore, flue dust, or fume, and matte, n.s.p.f. (lead content)		Lead in base bullion (lead content)		Pigs and bars (lead content)		Reclaimed scrap, etc. (lead content)		Sheets, pipe, and shot		Not otherwise specified (value)	Total value
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value		
1970	43	$8,360	1	$448	245	$73,397	3	$798	1	$241	$448	$83,692
1971	88	19,362	(2)	16	193	48,021	3	579	(2)	86	316	68,380
1972	52	10,554	1	238	246	64,096	2	450	(2)	52	326	75,716

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

Year	Babbitt metal, solder, white metal, and other combinations containing lead		
	Gross weight (short tons)	Lead content (short tons)	Value (thousands)
1970 r	1,846	984	$4,600
1971 r	1,497	570	4,433
1972	1,197	464	3,354

r Revised.

Table 31.—Lead: World mine production by country

(Short tons)

Country [1]	1970	1971	1972 [p]
North America:			
Canada	[r] 389,185	433,168	418,735
Guatemala	550	550	220
Honduras	17,598	19,805	22,844
Mexico [2]	194,665	172,900	178,307
United States [3]	571,767	578,550	618,915
South America:			
Argentina	39,228	44,636	43,498
Bolivia	27,995	25,491	20,895
Brazil	30,400	31,296	32,628
Chile	885	970	690
Colombia	323	226	324
Peru [4]	172,809	195,712	208,333
Europe:			
Austria [3]	6,617	8,504	7,350
Bulgaria	105,300	[e] 110,000	[e] 110,000
Czechoslovakia [e]	[r] 7,300	6,600	6,100
Finland	5,517	5,224	4,243
France	31,769	32,783	29,300
Germany, East [e]	11,000	5,500	6,500
Germany, West	44,653	45,306	42,393
Greece	10,171	11,570	[e] 12,000
Hungary [e]	1,910	1,910	1,910
Ireland	69,306	56,880	52,910
Italy	38,801	34,833	36,983
Norway	[r] 3,413	3,373	3,451
Poland	63,100	69,225	[e] 72,000
Portugal	1,717	1,524	1,214
Romania [e]	42,000	42,000	42,000
Spain	80,154	77,327	73,387
Sweden	[r] 86,324	87,583	81,900
U.S.S.R. [e]	485,000	496,000	510,000
United Kingdom	4,400	5,313	[e] 6,390
Yugoslavia	139,655	137,069	188,671
Africa:			
Algeria	7,200	5,200	5,500
Congo (Brazzaville)	88	33	[e] 17
Morocco	[r] 83,886	85,980	97,392
Nigeria [e]	--	237	354
South-West Africa, Territory of [5]	[r] 82,130	81,082	58,755
Tunisia	24,838	23,016	21,958
Zambia (refined)	30,093	30,500	28,500
Asia:			
Burma [e]	[r] 8,820	9,920	11,570
China, People's Republic of [e]	110,000	120,000	120,000
India	2,053	1,706	[e] 1,808
Indonesia [e]	220	220	220
Iran [6]	25,287	33,000	33,000
Japan [7]	70,996	77,808	69,946
Korea, North [e]	77,000	88,000	88,000
Korea, Republic of	17,655	18,236	16,234
Pakistan [e]	3	7	6
Philippines	15	--	--
Thailand	1,421	2,588	2,005
Turkey	[e] 12,000	7,260	[e] 6,864
Oceania:			
Australia	[r] 503,471	443,885	451,089
New Zealand [8]	858	1,373	1,273
Total	[r] 3,741,546	3,771,879	3,848,582

[e] Estimate. [p] Preliminary. [r] Revised.

[1] In addition to the countries listed, Pakistan, Uganda and Arab Republic of Egypt may produce lead, but available information is inadequate to make reliable estimates of output levels.

[2] Recoverable metal; content of lead in concentrate for exports plus lead content of domestic smelter products (refined lead, antimonial lead, mixed bars, and other unspecified items.)

[3] Recoverable metal.

[4] Recoverable metal; content of lead in concentrate for exports plus lead content of domestic smelter products (refined lead, antimonial lead, and bismuth-lead bars).

[5] For 1970 and 1971, data are for year ending June 30 and represent lead production from Tsumeb Corp., Limited, South-West Africa Co., Limited, and South African Iron and Steel Industrial Corporation, Rosh Pinah mine. For 1972 only, Tsumeb Corp. data is for calendar year 1972. Tsumeb Corp. production for 6 months ending December 1971 was 30,589 short tons.

[6] Year beginning March 21 of that stated.

[7] Content of concentrate.

[8] Contained in lead-copper concentrate.

Table 32.—Lead: World smelter production by country [1]

(Short tons)

Country	1970	1971	1972 p
North America:			
Canada (refined)	r 204,630	185,582	208,620
Guatemala [2]	83	99	24
Mexico (refined)	165,645	150,070	178,307
United States (refined) [3]	666,730	650,015	695,659
South America:			
Argentina	42,000	48,000	43,500
Bolivia (refined, including solder)	9	20	e 22
Brazil	21,259	28,287	27,594
Peru (refined)	79,340	74,004	94,311
Europe:			
Austria [4]	9,637	10,267	10,777
Belgium	98,549	87,413	e 99,200
Bulgaria [2]	108,700	e 110,000	e 110,000
Czechoslovakia [2]	19,417	19,412	e 19,400
France	132,207	119,314	150,002
Germany, East	27,000	22,000	20,900
Germany, West	r 124,340	108,470	112,440
Greece (refined)	15,722	12,912	17,747
Hungary e [2]	790	790	790
Italy	59,842	53,343	55,756
Netherlands	19,415	26,172	24,230
Poland (refined)	60,100	66,400	71,980
Portugal (refined)	631	1,300	1,300
Romania e	40,000	40,000	40,000
Spain	r 83,270	83,602	101,566
Sweden (refined)	44,800	35,500	52,470
U.S.S.R. (primary) e	485,000	490,000	510,000
United Kingdom [5]	48,246	42,580	27,615
Yugoslavia (refined) [2]	107,364	109,282	96,448
Africa:			
Morocco	27,449	20,631	--
South-West Africa, Territory of (refined) [6]	77,304	64,838	70,505
Tunisia	[7] 24,847	21,119	27,638
Zambia (refined)	30,093	30,500	28,500
Asia:			
Burma	r 8,555	9,576	10,946
China, People's Republic of e	110,000	110,000	110,000
India	2,053	1,707	2,917
Iran e [8]	200	200	200
Japan (refined)	230,383	237,056	246,064
Korea, North e	60,000	70,000	70,000
Korea, Republic of	3,968	3,456	4,196
Turkey e	220	220	220
Oceania:			
Australia (refined and bullion)	388,624	356,731	383,690
Total	r 3,628,422	3,500,868	3,725,534

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] Year ended June 30 of years 1970 and 1971. Data for 1972 are for fiscal year. Production for last 6 months of 1971 was 36,506 short tons.
[7] Lead in lead bars plus gross weight of antimonial lead; excludes lead in solder.
[8] Year beginning March 21 of year stated.

Lime

By Avery H. Reed [1]

Lime output in 1972 increased 4%, to 20.3 million tons, and set a new annual record. Total value was a record $341.1 million, 10% above 1971.

Santa Rita Mining Co. started up its new plant near Tucson, Ariz. The plant was established to service southern Arizona's copper industry with lime and fluxing stone. The kiln is an 11- by 275-ft rotary which had previously been used at a cement plant. Capacity is 16 tons per hour.

Inland Steel Co. announced plans to construct a 1,200-ton-per-day lime plant at Indiana Harbor, Ind. The plant is to be a Kennedy Van Saun Corp. project to serve the company's new basic oxygen furnace (BOF) steel mill at Indiana Harbor.

Paul Lime Plant, Inc. installed a new 10- by 300-ft rotary kiln at its plant near Douglas, Ariz. to supply lime to copper companies.

At Woodville, Ohio, Woodville Lime & Chemical Co. reopened its plant, which had been shut down for 10 years. A new

[1] Physical scientist, Division of Nonmetallic Minerals.

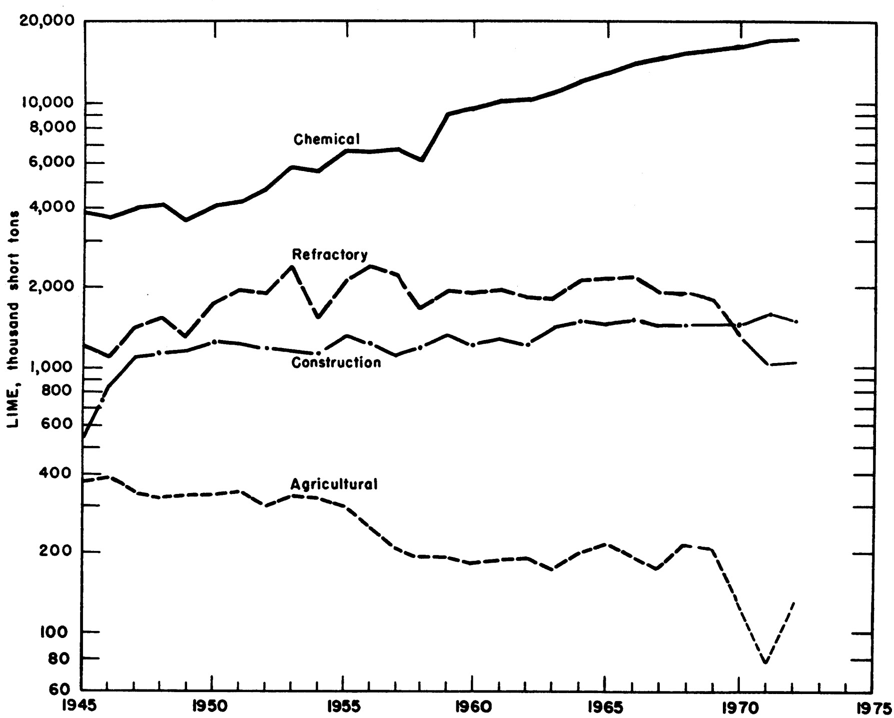

Figure 1.—Trends in major uses of lime.

Table 1.—Salient lime statistics in the United States [1]

(Thousand short tons and thousand dollars)

	1968	1969	1970	1971	1972
Number of plants	206	201	194	187	185
Sold or used by producers:					
Quicklime	14,440	15,479	15,248	15,138	16,611
Hydrated lime	2,364	2,864	3,126	3,446	2,604
Dead-burned dolomite	1,833	1,866	1,373	1,007	1,075
Total	18,637	20,209	19,747	19,591	20,290
Value [2]	249,639	280,736	286,155	308,100	339,304
Average value per ton	13.39	13.89	14.49	15.73	16.72
Lime sold	12,054	13,113	12,718	12,337	13,353
Lime used	6,583	7,096	7,029	7,254	6,937
Exports [3]	69	51	54	66	38
Imports for consumption [3]	73	184	202	242	248

[1] Excludes regenerated lime. Excludes Puerto Rico.
[2] Selling value, f.o.b. plant, excluding cost of containers.
[3] Bureau of the Census.

10- by 265-ft kiln was installed. Capacity is 330 tons per day.

Pfizer, Inc. added a seventh kiln at their Gibsonburg, Ohio, plant. Capacity of the new kiln is 130,000 tons per year.

DOMESTIC PRODUCTION

Lime producers sold or used 20.3 million tons, compared with 19.6 million tons in 1971. Sales of lime increased 8%, to 13.4 million tons, and were 2% above the 1969 record. Captive lime used by producers decreased 4% below the 1971 record. Output of refractory dolomite increased 7%, but was 56% below the 1956 record. The num-

Table 2.—Lime sold or used by producers in the United States, by State and kind [1]

(Thousand short tons and thousand dollars)

State	1971				1972			
	Hydrated	Quicklime	Total [2]	Value	Hydrated	Quicklime	Total [2]	Value
Alabama	137	624	761	11,454	136	603	739	11,751
Arizona	19	276	296	4,474	W	W	356	6,024
Arkansas	W	W	157	2,313	W	W	150	2,456
California	137	493	630	10,846	66	542	608	13,059
Colorado	46	146	193	3,039	W	W	187	4,070
Florida	W	W	159	2,958	W	W	180	3,527
Hawaii	7	1	8	228	W	W	7	266
Kansas	8	--	8	W	--	9	9	172
Louisiana	W	W	960	17,625	W	W	908	19,614
Maryland	W	W	W	W	5	11	17	W
Michigan	62	1,383	1,444	20,549	W	W	1,509	22,753
Montana	1	197	199	2,416	--	242	242	3,003
Nebraska	9	19	29	W	--	34	34	685
New Mexico	35	--	35	W	--	28	28	W
Ohio	267	3,740	4,007	65,258	243	4,171	4,413	75,569
Oregon	W	W	106	1,989	W	W	96	2,129
Pennsylvania	331	1,429	1,760	30,008	380	1,511	1,891	33,802
Puerto Rico	43	1	44	W	42	W	42	1,776
Texas	771	841	1,612	24,583	609	1,021	1,631	22,181
Utah	W	W	172	3,569	W	W	171	4,216
Virginia	63	696	759	11,049	69	690	758	11,739
West Virginia	W	W	197	3,073	W	W	W	W
Wisconsin	W	W	246	4,570	W	W	263	5,009
Wyoming	27	--	27	W	--	30	30	W
Other States [3]	1,526	6,300	5,826	89,814	1,095	8,795	6,064	97,279
Total [2]	3,489	16,146	19,635	309,813	2,645	17,687	20,332	341,080

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 Connecticut, Idaho, Illinois, Indiana, Iowa, Kentucky, Massachusetts, Minnesota, Mississippi, Missouri, Nevada, New Jersey, New York, North Dakota, Oklahoma, South Dakota, Tennessee, Washington, and States indicated by symbol W.

Table 3.—Lime sold or used by producers in the United States, by State and market [1]

(Thousand short tons)

State	1971 Plants	1971 Sold	1971 Captive	1971 Total [2]	1972 Plants	1972 Sold	1972 Captive	1972 Total [2]
Alabama	5	W	W	761	5	W	W	739
Arizona	7	180	117	296	8	222	133	356
Arkansas	3	W	W	157	3	W	W	150
California	15	239	391	630	15	223	385	608
Colorado	11	7	186	193	11	5	182	187
Florida	3	W	W	159	3	W	W	180
Hawaii	2	2	7	8	2	W	W	7
Kansas	1	--	8	8	1	--	9	9
Louisiana	4	W	W	960	4	W	W	908
Maryland	2	W	W	W	1	17	--	17
Michigan	10	W	W	1,444	10	W	W	1,509
Montana	4	--	199	199	3	--	242	242
Nebraska	4	--	29	29	5	--	34	34
New Mexico	1	--	35	35	1	--	28	28
Ohio	19	2,217	1,789	4,007	19	2,525	1,888	4,413
Oregon	3	W	W	106	3	W	W	96
Pennsylvania	11	W	W	1,760	11	W	W	1,891
Puerto Rico	1	43	1	44	1	42	--	42
Texas	14	853	759	1,612	15	1,061	570	1,631
Utah	6	W	W	172	5	W	W	171
Virginia	8	W	W	759	7	W	W	758
West Virginia	3	W	W	197	2	W	W	W
Wisconsin	6	W	W	246	6	263	--	263
Wyoming	3	--	27	27	3	--	30	30
Other States [3]	42	8,839	3,706	5,826	42	9,028	3,446	6,064
Total [2]	188	12,380	7,254	19,635	186	13,385	6,947	20,332

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 Connecticut (1 plant), Idaho (1), Illinois (5), Indiana (1), Iowa (2), Kentucky (1), Massachusetts (2), Minnesota (4), Mississippi (1), Missouri (4), Nevada (3), New Jersey (1), New York (3), North Dakota (1), Oklahoma (2), South Dakota (2), Tennessee (2), Washington (3), and States indicated by symbol W.

Table 4.—Lime sold or used by producers in the United States, by size of plant [1]

(Thousand short tons)

Size of plant	1971 Plants	1971 Quantity	1971 % of total	1972 Plants	1972 Quantity	1972 % of total
Less than 10,000	30	138	1	35	176	1
10,000 to 25,000	37	590	3	33	537	3
25,000 to 50,000	37	1,404	7	31	1,087	5
50,000 to 100,000	26	1,775	9	30	2,207	11
100,000 to 200,000	25	3,805	19	21	3,052	15
200,000 to 400,000	26	7,215	37	29	8,508	42
More than 400,000	7	4,708	24	7	4,765	23
Total	188	19,635	100	186	20,332	100

[1] Excludes regenerated lime. Includes Puerto Rico.

ber of plants decreased from 188 to 186 and the average output per plant increased from 104,400 tons per year to 109,300 tons.

Six States, Ohio, Missouri, Pennsylvania, Texas, Michigan, and Illinois, accounted for 61% of the total output.

Leading producing companies were Marblehead Lime Co. with four plants in Illinois and one each in Indiana, Michigan, Pennsylvania, and Missouri; Mississippi Lime Co. in Missouri; Allied Chemical Corp. in New York and Louisiana; PPG Industries, Inc. in Ohio and Texas; Bethlehem Steel Corp. with two plants in Pennsylvania and one in New York; Martin-Marietta Chemicals in Ohio and Alabama; United States Gypsum Co. with two plants in Texas and one each in Alabama, Ohio, and Louisiana; Pfizer, Inc. in Ohio, Massachusetts, California, and Connecticut; Warner Co. with two plants in Pennsylvania; and Diamond Shamrock Chemical Co. in Ohio. These 10 companies, operating 30 plants, accounted for 45% of the total lime production.

The seven largest lime plants, each producing more than 400,000 tons per year, accounted for 23% of the total production. There were 36 plants which produced more than 200,000 tons per year and accounted for 65% of the total output.

CONSUMPTION AND USES

Lime was consumed in every State. For total lime, the leading consuming States were Ohio, Pennsylvania, Michigan, Texas, Indiana, and Illinois. These six States, each of which consumed more than 1 million tons, accounted for 58% of the total lime consumed.

Leading quicklime-consuming States were Ohio, Pennsylvania, Michigan, Indiana, and Texas, each of which consumed more than 1 million tons. Combined, these five States accounted for 54% of quicklime consumption.

Texas, Pennsylvania, Ohio, Illinois, Oklahoma, and Louisiana were the leading hydrate consuming States, each of which consumed more than 100,000 tons. These six States accounted for 54% of the hydrate consumed.

Table 5.—Lime sold or used by producers in the United States, by use [1]

(Thousand short tons and thousand dollars)

Use	1971				1972			
	Sold	Used	Total [2]	Value	Sold	Used	Total [2]	Value
Agriculture	80	--	80	1,449	137	--	137	2,711
Construction:								
Soil stabilization	832	--	832	15,982	884	--	884	17,046
Mason's lime	414	W	W	9,055	W	W	411	7,924
Finishing lime	222	--	222	4,257	W	W	229	4,415
Other uses	31	--	31	604	60	--	60	1,157
Total [2]	1,499	W	W	29,898	W	W	1,586	30,542
Chemical and industrial:								
Steel BOF	4,183	985	5,167	76,352	4,921	1,126	6,047	98,570
Alkalies	W	W	3,462	52,391	10	3,222	3,233	52,700
Water purification	W	W	1,273	19,638	W	W	1,403	22,870
Paper and pulp	W	W	869	13,792	W	W	787	12,830
Sugar refining	39	749	787	14,625	41	718	759	12,370
Steel, open-hearth	W	W	535	7,788	W	W	665	10,840
Steel, electric	W	W	560	8,221	W	W	641	10,450
Copper ore concentration	216	269	485	6,639	264	283	548	8,923
Sewage treatment	273	76	349	5,305	334	100	434	7,074
Glass	347	--	347	5,126	372	--	372	6,064
Aluminum and bauxite	W	W	364	5,012	W	W	368	5,998
Calcium carbide	304	233	537	7,298	W	W	357	5,819
Magnesia from sea water	W	W	298	4,385	W	W	316	5,151
Food	30	--	30	576	W	W	77	1,257
Other metallurgy	W	W	92	1,354	W	W	53	868
Acid mine water	W	W	W	W	W	W	49	791
Petroleum refining	49	--	49	784	47	--	47	765
Insecticides	32	--	32	569	30	--	30	484
Other ore concentration	36	--	36	404	W	W	26	424
Tanning	30	--	30	588	24	--	24	396
Oil well drilling	12	--	12	204	13	--	13	211
Fertilizer	W	W	W	W	9	--	9	146
Sand-lime brick	6	--	6	96	4	--	4	70
Paint	4	--	4	62	3	--	3	53
Rubber	2	--	2	35	W	W	3	43
Wire drawing	W	W	W	W	W	W	2	30
Silica brick	7	W	7	104	W	W	2	27
Sulfur removal from stack gases	W	W	W	W	W	W	1	23
Other uses [3]	4,266	W	W	27,015	W	W	1,261	20,538
Total	9,836	W	W	258,363	W	W	17,534	285,785
Refractory dolomite	965	42	1,007	20,103	1,006	69	1,075	22,042
Grand total [2]	12,380	7,254	19,635	309,813	13,395	6,937	20,332	341,080

W Withheld to avoid disclosing individual company confidential data.
[1] Excludes regenerated lime. Includes Puerto Rico.
[2] Data may not add to totals shown because of independent rounding.
[3] Includes magnesite, petrochemicals, chrome, magnesium metal, precipitated calcium carbonate (1972), coke, lithium (1972), manganese and ferromanganese, explosives (1972), plastics (1972), adhesives (1972), whiting (1971), and uses indicated by symbol W.

Table 6.—Destination of shipments of lime sold or used by producers in the United States in 1972, by State [1]

(Short tons)

State	Quicklime	Hydrated lime	Total
Alabama	309,113	76,339	385,452
Arizona	323,535	20,600	344,135
Arkansas	127,524	24,520	152,044
California	683,626	110,623	794,249
Colorado	206,292	17,789	224,081
Connecticut	W	W	49,839
Delaware	15,460	12,387	27,847
District of Columbia	--	2,099	2,099
Florida	265,724	51,127	316,851
Georgia	85,968	26,396	112,364
Hawaii	W	W	6,609
Idaho	W	W	125,935
Illinois	890,832	132,185	1,023,017
Indiana	W	W	1,533,904
Iowa	62,388	18,461	80,849
Kansas	43,872	29,360	73,232
Kentucky	466,867	18,591	485,458
Louisiana	811,393	107,552	918,945
Maryland	W	W	406,934
Massachusetts	W	W	68,843
Michigan	1,609,982	44,114	1,654,096
Minnesota	W	W	139,293
Mississippi	125,759	21,761	147,520
Missouri	W	W	208,275
Montana	246,499	4,366	250,865
Nebraska	43,332	14,792	58,124
Nevada	W	W	51,639
New Jersey	56,291	88,554	144,845
New Mexico	W	W	81,122
New York	938,527	60,021	998,548
North Carolina	95,652	30,270	125,922
North Dakota	W	W	36,813
Ohio	3,488,413	166,343	3,654,756
Oregon	101,850	16,099	117,949
Pennsylvania	2,015,111	246,523	2,261,634
Rhode Island	W	W	11,976
South Carolina	36,461	7,787	44,248
South Dakota	W	W	26,277
Tennessee	93,767	42,213	135,980
Texas	1,032,812	593,015	1,625,827
Utah	W	W	139,955
Virginia	110,640	39,054	149,694
Washington	145,781	18,889	164,670
West Virginia	312,331	31,186	343,517
Wisconsin	105,636	46,763	152,399
Exports:			
Canada	9,677	11,460	21,137
Mexico	W	W	707
Other countries	W	W	35,918
Other States [2]	2,825,512	514,069	415,542
Total	17,686,627	2,645,308	20,331,935

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Excludes regenerated lime. Includes Puerto Rico.
[2] Includes Alaska, Maine, New Hampshire, Oklahoma, Puerto Rico, Vermont, Wyoming, and destinations indicated by symbol W.

Lime sold by producers was used for chemicals (80%), construction (11%), refractories (8%), and agriculture (1%).

Captive lime used by producers was 34% of the total, compared with 37% in 1971 and 36% in 1970.

Leading individual uses were basic oxygen steel furnaces, alkalies, water purification, and refractories, which together accounted for 58% of the total consumption, compared with 56% in 1971.

Lime used in agriculture reversed the downward trend of recent years and expanded 72%. Lime used for refractory dolomite also reversed the downward trend and increased 7%. Construction uses continued to expand, increasing 2%. Lime for chemical and industrial use also continued to expand, increasing 9%.

PRICES

The average value of lime sold or used by producers in 1972 was $16.78 per ton, an increase of 6% over the 1971 value of $15.78 per ton.

Values for quicklime ranged from $15.76 for agricultural lime to $16.08 for chemical lime, $16.90 for construction, and $20.52 for refractory dolomite, and averaged $16.35 per ton. Each of these values was higher than in 1971.

Values for hydrated lime ranged from $19.45 for construction lime to $19.66 for chemical lime and $21.32 for agricultural lime, averaging $19.60 per ton.

FOREIGN TRADE

Exports of lime decreased 43%, to 37,659 tons, and were 45% below the 1968 record. Of the total quantity exported, Canada received 68%, Surinam 14%, and Mexico 7%. The remaining 11% went to 35 countries, listed in order as follows: Panama, Jamaica, British Bahamas, Haiti, Indonesia, West Germany, the United Kingdom, Japan, Belgium, British Honduras, Sweden, Nicaragua, Venezuela, Argentina, Ecuador, the Philippines, Leeward and Windward Islands, Denmark, Austria, Brazil, Chile, Honduras, Thailand, New Zealand, Colombia, Australia, the Netherlands Antilles, the Dominican Republic, Iceland, Pacific Trust Islands, India, the Republic of South Africa, Hungary, Italy, and Zambia.

Imports of lime, mainly from Canada, increased to 248,500 tons, 3% above the 1971 record. Small quantities were imported from the Dominican Republic (1,088 tons), Mexico (231 tons), France (102 tons), and West Germany (52 tons).

Table 7.—U.S. exports of lime

Year	Short tons	Value (thousands)
1970	53,876	$1,391
1971	65,862	1,971
1972	37,659	1,242

Table 8.—U.S. imports for consumption of lime

Year	Hydrated lime		Other lime		Total	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1970	34,158	$479	167,432	$1,946	201,590	$2,425
1971	39,807	618	202,477	2,690	242,284	3,308
1972	37,468	724	210,995	3,224	248,463	3,948

WORLD REVIEW

Canada.—During 1972 there were 22 active lime plants in Canada: nine in Ontario, four in Quebec, four in Alberta, three in Manitoba, one in British Columbia, and one in New Brunswick. Of the 80 kilns in operation, 55 were vertical, 21 were rotary, 3 were rotary grate, and 1 was vibatory grate. Output in 1972 was 1,606,000 tons.

Companies active in Ontario were Algoma Steel Corp. Ltd., Allied Chemical Canada Ltd., Canadian Gypsum Co. Ltd., Cyanamid of Canada Ltd., Chromasco Corp. Ltd., Domtar Chemicals Ltd., Reiss Lime Co. of Canada Ltd., and The Steel Co. of Canada Ltd.

Active companies in Quebec were Dominion Lime Ltd., Domtar Chemicals Ltd., Gulf Oil Canada Ltd., and Quebec Sugar Refinery. Dominion Lime announced plans for a new 100-ton-per-day kiln.

In Alberta three companies produced lime, Canadian Sugar Factories Ltd., Steel Brothers Canada Ltd., and Summit Lime Works, Ltd. Steel Brothers constructed a second rotary kiln in 1972 which doubled the plant capacity. Steel Brothers Canada Ltd. and The Manitoba Sugar Co. Ltd. were active in Manitoba. Texada Lime, Ltd. built a calcimatic kiln in British Columbia. Havelock Lime Works Ltd. installed a 100-ton rotary kiln at Havelock, New Brunswick.

Germany, West.—West Germany ranked

third in world lime production, accounting for 11% of the world total. Most of the lime was consumed in Germany.

Israel.—Even Vesid, Ltd. announced plans for a 200-ton-per-day rotary kiln to be built at Shfeya.

U.S.S.R.—The U.S.S.R. was the leading lime producing country in the world, accounting for 22% of the world total. The lime was used for construction (51%), iron and steel (25%), chemicals (13%), and sugar (11%).

Table 9.—Quicklime and hydrated lime, including dead-burned dolomite: World production by country

(Thousand short tons)

Country [1]	1970	1971	1972 [p]
North America:			
Canada	[r] 1,648	1,519	1,606
Costa Rica	11	12	13
Guatemala	24	[e] 25	[e] 25
Puerto Rico	41	44	42
United States (sold or used by producers)	19,747	19,591	20,290
South America:			
Brazil [e]	1,800	2,200	2,200
Colombia [e]	1,100	1,100	1,100
Paraguay	23	26	26
Peru	11	[e] 11	[e] 11
Uruguay	67	53	[e] 55
Europe:			
Austria [2]	820	741	788
Belgium	3,187	3,311	3,168
Bulgaria	1,036	[e] 1,047	[e] 1,047
Czechoslovakia [3]	2,368	2,485	[e] 2,590
Denmark	197	197	[e] 198
Finland	254	254	259
France	4,819	[e] 4,900	[e] 4,900
Germany, East	2,946	3,097	[e] 3,200
Germany, West	11,812	11,641	12,031
Hungary	719	671	[e] 661
Ireland	65	60	55
Italy	[e] 6,400	4,630	[e] 4,400
Norway	[r] 105	[e] 105	[e] 105
Poland	3,875	4,142	4,456
Portugal	233	[e] 243	[e] 243
Romania	2,217	2,481	[e] 2,535
Spain	[r] 451	[e] 550	[e] 550
Sweden	897	907	[e] 915
Switzerland	160	157	165
U.S.S.R. [e]	23,700	23,100	24,300
Yugoslavia	1,662	1,755	1,888
Africa:			
Algeria [e]	22	22	22
Ethiopia (including Eritrea)	20	15	19
South Africa, Republic of (sales)	[r] 1,189	1,205	1,316
Tanzania	7	6	[e] 4
Tunisia	183	183	187
Uganda	23	[e] 20	[e] 20
Zambia	115	[e] 115	[e] 115
Asia:			
Cyprus	[r] 87	118	132
India	508	590	373
Iran [e]	1,100	1,100	1,100
Israel	143	198	198
Japan	10,110	10,934	11,166
Jordan	--	--	2
Kuwait	1	[e] 1	[e] 1
Lebanon	143	138	132
Mongolia [e]	44	44	44
Philippines	179	246	312
Saudi Arabia	24	[e] 24	[e] 24
Taiwan	141	188	195
Oceania:			
Australia [e] [4]	[r] 231	254	259
Fiji Islands	3	--	4
Total	106,668	106,456	109,447

[e] Estimate. [p] Preliminary. [r] Revised.

[1] Lime is produced in many other countries besides those listed. Zaire, Mexico, Nicaragua, Venezuela and United Kingdom are among the more important countries for which official data are unavailable.

[2] Includes lime for agriculture for 1970, excludes lime for agriculture for 1971 and 1972.

[3] Excludes output by small producers.

[4] Year ending June 30 of that stated.

TECHNOLOGY

Tarmac Roadstone Holdings, Ltd. of England, successfully converted a shaft-type lime kiln to the use of liquid butane.

Air pollutants from a rotary lime kiln are dependent on the stone charged and the fuel used. The gaseous effluent usually consists of water vapor, carbon dioxide, and nitrogen, and may contain sulfur oxides. The particulate emissions usually include flyash, lime dust, limestone dust and tars, and may include unburned coal. The quantity of dust from a lime kiln may range up to 15% of the kiln feed.

New environmental regulations require the abatement of these air pollutants or forced closure of the plant. Present applications use the wet scrubber, fabric filter, or electric precipitator. Alternate methods, which will also control the gaseous emissions, are being studied.

Magnesium

By E. Chin [1]

Production and shipments of magnesium metal by The Dow Chemical Company were 120,823 short tons and 111,185 short tons, respectively, in 1972. Disposal of magnesium from the Government stockpile throughout the year totaled 7,737 tons.

Currently, domestic capacity to produce primary magnesium metal represents 58% of the total world production capacity. With the entry of a fourth U.S. producer of magnesium metal, total domestic production capacity will be 235,000 short tons per year by 1975.

Legislation and Government Programs.—In 1970, the Office of Emergency Preparedness removed magnesium metal from the list of strategic and critical materials, and the stockpile objective for magnesium was abolished. Under authority of Public Laws 90–604, 91–321, and 92–113, the General Services Administration (GSA) continued the disposal of all the magnesium remaining in the national stockpile.

In 1970, GSA sold 14,572 short tons of metal from the Government stockpile, compared with 710 tons in 1971. A total of 7,737 short tons of magnesium was sold during 1972, leaving 89,926 short tons in the stockpile at yearend.

[1] Physical scientist, Division of Nonferrous Metals.

Table 1.—Salient magnesium statistics
(Short tons)

	1968	1969	1970	1971	1972
United States:					
Production:					
Primary magnesium	98,375	99,887	112,006	123,485	120,823
Secondary magnesium	15,525	13,470	12,042	14,703	15,662
Shipments: Primary	103,671	117,695	118,693	120,217	111,185
Exports	19,457	27,372	35,732	24,311	17,556
Imports for consumption	4,808	4,316	3,295	3,671	4,479
Consumption	86,427	95,132	93,495	90,458	99,455
Price per pound cents	35.25	35.25	35.25	36.25	37.25
World: Primary production	212,305	221,469	242,253	255,753	255,995

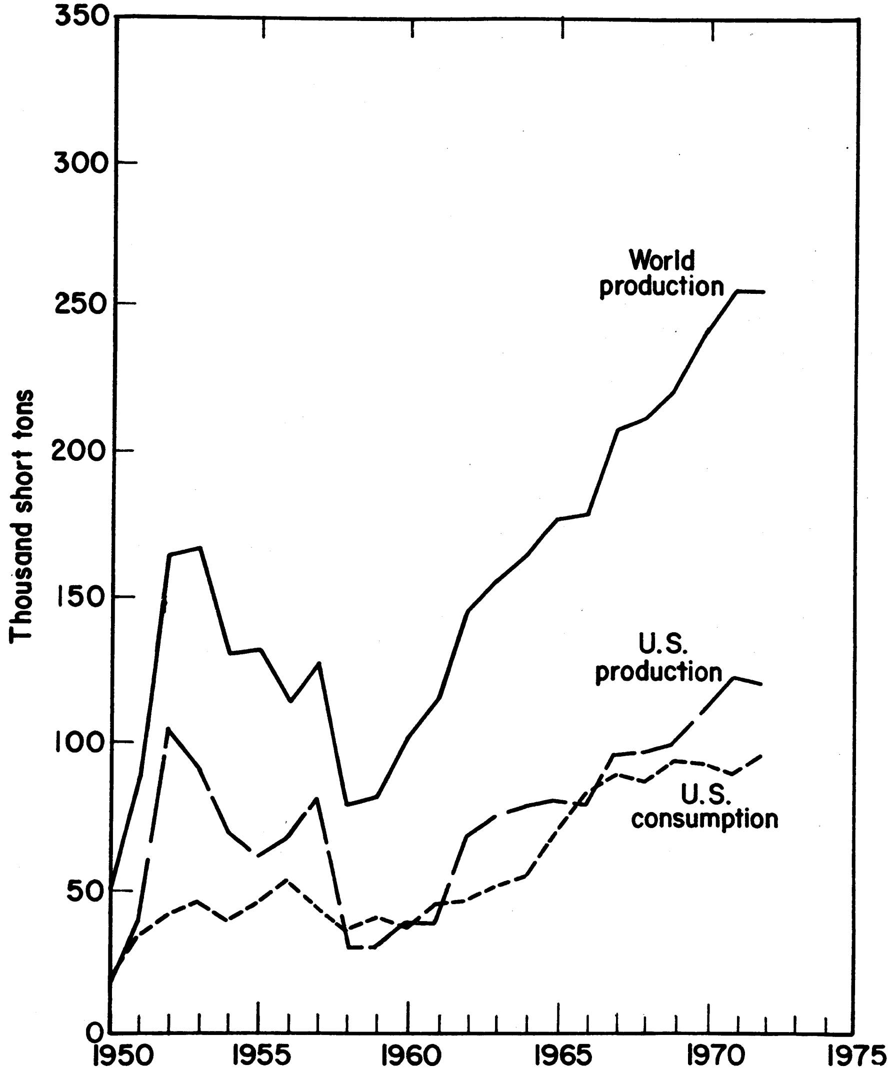

Figure 1.—U.S. and world production and U.S. consumption of primary magnesium.

DOMESTIC PRODUCTION

Production of primary magnesium metal by The Dow Chemical Co. at Freeport, Tex., was 120,823 short tons in 1972. American Magnesium Co. (American Magnesium) at Snyder, Tex., and NL Industries, Inc. (NL), at Rowley, Utah, also produced some metal.

In compliance with an order of the Texas Air Control Board, American Magnesium halted production in mid-1971 to effect improvements in the effluent control systems at its plant. In 1972, American Magnesium was granted a license to use a U.S.S.R.-designed electrolytic cell. Soviet technicians visited the electrolytic plant at Snyder, Tex., to assist American Magnesium's personnel with the operation of the cell, which is reportedly the largest in the Western World. Late in the year, the reduction plant was operated intermittently and some magnesium metal was produced.

Late in 1972, NL initiated operational startup of its magnesium reduction plant, located on the southwestern shore of the Great Salt Lake, near Rowley and Grantsville, Tooele County, Utah. NL's electrolytic plant has a rated annual capacity of 45,000 tons per year of magnesium metal and 70,000 tons of chlorine. Electrical power for NL's project was supplied by the Utah Power and Light Co.

NL's process uses a modified electrolytic cell of the I.G. Farben design and a closed metal circulation system. Raw material source is the brine from the Great Salt Lake which contains approximately 0.7% magnesium, about five times more than sea water. The lake brines are pumped into precipitation ponds where solar evaporation increases the concentration of the magnesium chloride from 2.5% to 30%. From there it is pumped into holding tanks for storage as raw material feed. The storage tanks hold more than a 1-year supply of magnesium chloride for cell feed.

Early in 1972, Great Salt Lake Minerals and Chemicals Corp. (GSL) received $2.975 million from Dow in cancellation payments for the $3 million magnesium chloride facility GSL built at Ogden, Utah. The facility was to supply magnesium chloride for Dow's proposed magnesium plant at Dallesport, Oreg. In 1971, Dow indefinitely delayed the construction of the Dallesport magnesium chloride reduction facility.

The Aluminum Company of America (Alcoa) acquired a license from France's Péchiney Ugine Kuhlmann to use the Magnetherm process for the production of magnesium metal. The magnesium plant, to be situated at Addy, Wash., will use dolomitic limestone deposits in the area for the metal production. The Magnetherm process involves the reduction of calcined dolomite by ferrosilicon at temperatures in excess of 1,500° C. Northwest Alloys, Inc., a newly formed Alcoa subsidiary, will begin construction of the facility in April 1973 with startup targeted for March 1975. Initial capacity will be 24,000 tons per year of magnesium and an ultimate capacity of 40,000 tons per year. The $50 million facility will have a work force of 200 to 250 persons, and will be increased to 300 to 400 persons as capacity is brought up to 40,000 tons per year. The Bonneville Power Administration will supply electricity beginning in October 1974 to the 240-acre Addy site located 50 miles northwest of Spokane. The magnesium and byproduct silicon, two important alloying agents for aluminum, will be used internally by Alcoa.

Table 2.—Magnesium recovered from scrap processed in the United States, by kind of scrap and form of recovery

(Short tons)

	1968	1969	1970	1971 r	1972 p
Kind of scrap:					
New scrap:					
Magnesium-base	7,006	4,767	4,564	6,722	6,816
Aluminum-base	5,050	5,712	4,698	4,838	5,646
Total	12,056	10,479	9,262	11,560	12,462
Old scrap:					
Magnesium-base	2,113	1,700	1,518	1,719	1,656
Aluminum-base	1,356	1,291	1,262	1,424	1,544
Total	3,469	2,991	2,780	3,143	3,200
Grand total	15,525	13,470	12,042	14,703	15,662
Form of recovery:					
Magnesium alloy ingot [1]	2,502	3,231	2,006	3,905	3,612
Magnesium alloy castings (gross weight)	15	11	13	14	9
Magnesium alloy shapes	82	149	189	500	275
Aluminum alloys	9,900	8,378	7,088	7,423	8,790
Zinc and other alloys	18	13	24	17	16
Chemical and other dissipative uses	64	65	80	478	581
Cathodic protection	2,944	1,623	2,642	2,366	2,379
Total	15,525	13,470	12,042	14,703	15,662

r Revised. p Preliminary.
[1] Figures include secondary magnesium content of both secondary and primary magnesium alloy ingot.

CONSUMPTION AND USES

Consumption of magnesium in the United States reversed the 1971 decline and rose to almost 100,000 short tons. Magnesium metal is consumed in two broad categories: Structural products such as castings and wrought products, and distributive or sacrificial applications where advantage is taken of the metal's chemical properties. At present, about one-third of consumption is for structural applications while sacrificial uses account for the remaining two-thirds of magnesium consumption.

A wide-ranging series of applications for magnesium were noted in 1972. Archery bow handles, baseball bats, bowling pins, pack frames, snowmobile parts, and staple nailers were among the promising new uses for magnesium die castings. A yttrium-zinc-magnesium base alloy, developed by the Frankford Arsenal, was being used and tested for various helicopter parts. An aluminum-magnesium-steel shield will cap the Centaur booster and Viking spacecraft scheduled to be launched for Mars in 1976.

The use of magnesium and aluminum in U.S. automobiles is expected to increase sharply in the next 5 years, due to the necessity of minimizing the weight of cars. The target for weight reduction per car is about 300 pounds, approximately the weight of mandatory safety and emission control equipment. Some new car models to be introduced in the fall of 1973 will feature magnesium fender extensions as well as decorative items.

The Melmag racing car wheel, designed by Magnesium Elektron, Ltd., won the 1972 Design Award of the International Magnesium Association. The one-piece, magnesium die-cast deck of the Satellite lawnmower, produced for the Parkton Corp. by Paramount Die Casting, Inc. was awarded first prize in the current production category in the First International Magnesium Die Casting Competition.

In sacrificial applications, the area of magnesium growth was expected to be in such uses as the desulfurization of steel and in anodes for the cathodic protection of buried pipelines and storage tanks. Magnesium dry cell batteries for walkie-talkies are a new application for wrought metal, and magnesium continued to be used in water-activated and sea water-activated reserve cell batteries. Retail sales of dry-cell batteries, excluding those for military applications, were expected to reach $400 million in 1973, and the market was estimated to be growing at more than 10% per year. The alkaline-magnesium cell market, the fastest growing segment, was expected to reach $60 million.

Table 3.—Consumption of primary magnesium in the United States, by use

(Short tons)

	1968	1969	1970	1971 r	1972 p
For structural products:					
Castings:					
Die	7,337	7,484	9,002	7,477	8,600
Permanent mold	607	404	260	779	955
Sand	3,740	2,562	1,735	1,143	768
Wrought products:					
Extrusions	11,280	13,110	12,250	5,481	8,045
Sheet and plate	(1)	(1)	(1)	4,447	5,992
Other (includes forgings)	(1)	(1)	(1)	2,782	1,377
Total	22,964	23,560	23,247	22,109	25,737
For distributive or sacrificial purposes:					
Alloys:					
Aluminum	34,484	37,375	36,543	37,335	40,568
Copper	(2)	(2)	(2)	1,576	1,563
Zinc	52	54	35	26	28
Other	(2)	(2)	(2)	175	983
Cathodic protection (anodes)	5,714	6,087	5,778	7,050	6,428
Chemical	(2)	(2)	8,385	8,960	9,732
Nodular iron	2,480	2,374	4,720	4,135	4,684
Powder	(2)	(2)	5,646	3,410	(2)
Scavenger and deoxidizer	(2)	(2)	(2)	68	327
Reducing agent for titanium, zirconium, hafnium, uranium, and beryllium	6,209	7,363	6,300	5,587	6,089
Other	14,524	18,319	2,841	27	3,316
Total	63,463	71,572	70,248	68,349	73,718
Grand total	86,427	95,132	93,495	90,458	99,455

r Revised. p Preliminary.
1 Included with "Extrusions."
2 Included with "Other."

PRICES

During 1972, the quoted base price for primary magnesium pig and ingot in 10,000-pound lots, 99.8% magnesium, f.o.b. plant, was 37.25 and 38.00 cents per pound, respectively. This compares with corresponding prices of 36.25 and 37.00 cents per pound, respectively, during 1971.

Depending upon the state of preservation of the metal available from the national stockpile, GSA accepted bids for primary magnesium ranging from 28.25 to 34.75 cents per pound, f.o.b. storage locations. The average price of metal sold by GSA during the year was 32.45 cents per pound.

STOCKS

Producer and consumer stocks of primary magnesium totaled 22,011 tons as of December 31, 1972. Yearend stocks of primary magnesium alloy ingot were 986 short tons. Stocks a year earlier were 13,021 short tons of primary metal and 1,727 short tons of alloy ingot.

Table 4.—Stocks and consumption of new and old magnesium scrap in the United States in 1972

(Short tons)

Item	Stocks Jan. 1 [r]	Receipts	Consumption			Stocks Dec. 31
			New scrap	Old scrap	Total	
Cast scrap	153	1,899	644	1,197	1,841	211
Solid wrought scrap [1]	736	4,969	4,588	--	4,588	1,117
Total	889	6,868	5,232	1,197	6,429	1,328

[r] Revised.
[1] Includes borings, turnings, drosses, etc.

FOREIGN TRADE

As in prior years, the United States continued to be a net exporter of magnesium metal in 1972. However, U.S. exports of magnesium metal in all forms, declined from 24,311 short tons, valued at $15.7 million in 1971, to 17,556 tons, valued at $11.7 million in 1972. For the past decade, West Germany was the largest single export destination for U.S. metal. However, in 1972 U.S. exports to West Germany declined sharply, totaling only 859 tons.

Imports by Brazil, Canada, and Japan accounted for 31, 20, and 7%, respectively, of the total U.S. magnesium metal exported. Shipments to France, Italy, Mexico, Switzerland, the United Kingdom, and West Germany collectively totaled 4,157 tons or 24% of total exports. The remaining 3,113 tons were exported to some 20 countries.

Total U.S. imports for consumption of magnesium were 4,479 short tons, valued at $2.6 million in 1972, compared to 3,671 tons, valued at $2.3 million in 1971. Canada, the largest of U.S. sources in 1972, contributed 1,618 tons of the total metal imported. Receipts from West Germany and the Netherlands were, respectively, 1,101 and 513 tons. The remainder of U.S. imports, 1,247 tons, was contributed by 15 other nations.

The duty on unwrought magnesium, other than alloys was 20% ad valorem, and on unwrought magnesium alloy (magnesium content) was 8 cents per pound plus 4% ad valorem. The duty on wrought magnesium metal was 6.5 cents per pound plus 3.5% ad valorem.

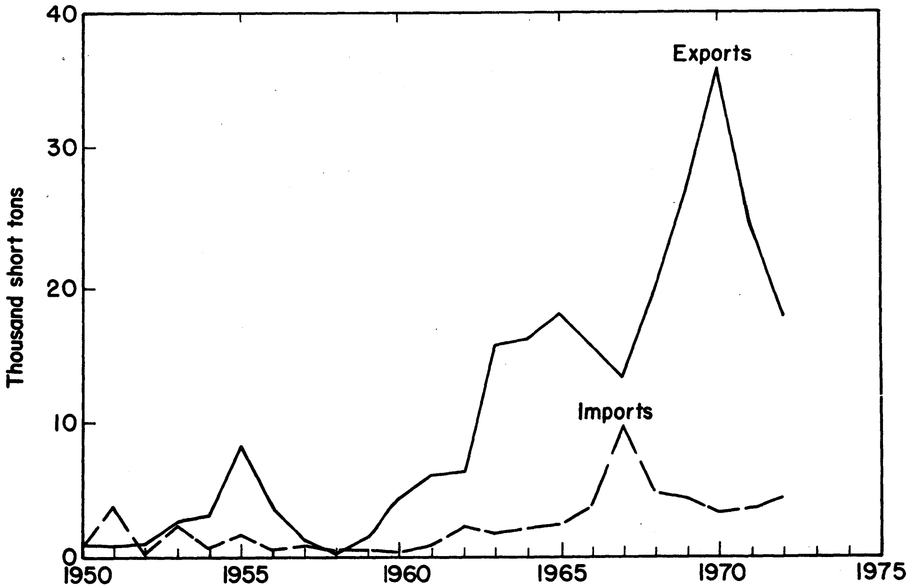

Figure 2.—U.S. imports and exports of magnesium.

Tables 5.—U.S. exports of magnesium, by class and country

Destination	1971						1972					
	Waste and scrap		Primary metals, alloys		Semifabricated forms, n.e.c., including powder		Waste and scrap		Primary metals, alloys		Semifabricated forms, n.e.c., including powder	
	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)
Angola	--	--	--	--	60	$77	--	--	2	$2	--	--
Argentina	--	--	502	$374	1	6	--	--	313	232	--	--
Australia	--	--	455	294	46	106	--	--	312	168	45	$74
Austria	--	--	48	29	--	--	--	--	22	12	5	10
Belgium-Luxembourg	--	--	225	135	3	9	33	$11	135	78	1	6
Brazil	--	--	6,692	3,787	2	6	--	--	5,439	3,360	3	10
Canada	22	$94	2,002	1,225	207	291	27	80	3,253	1,907	289	397
Colombia	--	--	12	9	5	12	--	--	8	7	2	4
Egypt	--	--	7	4	--	--	--	--	34	24	--	--
France	--	--	36	25	17	38	--	--	432	247	17	48
Germany, West	--	--	9,857	5,742	137	317	--	--	801	506	58	154
Ghana	--	--	1	1	2	2	--	--	225	148	1	1
India	1	1	8	7	--	--	--	--	283	169	--	--
Indonesia	--	--	--	--	--	--	--	--	7	8	--	--
Israel	--	--	6	4	35	54	--	--	21	15	40	57
Italy	1	1	673	411	51	43	--	--	425	258	16	37
Japan	17	11	213	119	243	435	21	7	1,000	591	254	480
Malaysia	--	--	--	--	--	--	--	--	25	14	--	--
Mexico	--	--	910	705	32	41	11	15	938	609	5	10
Netherlands	--	--	282	155	34	104	--	--	385	228	21	36
New Zealand	--	--	15	9	--	--	--	--	45	26	--	--
Norway	--	--	106	60	1	1	--	--	95	56	--	--
Pakistan	--	--	--	--	--	--	--	--	24	15	--	--
South Africa, Republic of	--	--	112	63	2	1	--	--	190	113	1	1
Spain	--	--	457	256	4	6	--	--	386	219	2	3
Sweden	--	--	--	--	33	93	--	--	--	--	17	27
Switzerland	--	--	65	48	1	1	--	--	721	444	6	10
Taiwan	--	--	66	43	--	--	--	--	129	70	(1)	1
United Kingdom	--	--	350	195	17	46	--	--	711	410	16	36
Venezuela	--	--	148	113	32	33	2	3	189	126	13	15
Other	--	--	50	35	7	15	(1)	(1)	92	70	8	37
Total	41	107	23,298	13,848	972	1,737	94	116	16,642	10,132	820	1,454

[1] Less than ½ unit.

Table 6.—U.S. exports and imports for consumption of magnesium

Year	Exports					
	Waste and scrap		Metals and alloys in crude form		Semifabricated forms, n.e.c.	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1970	42	$30	34,143	$20,090	1,547	$2,422
1971	41	107	23,298	13,848	972	1,737
1972	94	116	16,642	10,132	820	1,454

Year	Imports							
	Waste and scrap		Metal		Alloys (magnesium content)		Powder, sheets, tubing, ribbons, wire and other forms (magnesium content)	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1970	1,632	$651	1,316	$915	122	$300	225	$637
1971	2,142	713	1,300	920	99	286	130	397
1972	3,042	1,040	1,256	950	168	464	13	103

WORLD REVIEW

World production of magnesium metal in 1972, excluding two U.S. producers, was 255,995 short tons, an increase of 242 tons over world production in 1971. The United States produced 47% of the world magnesium output, followed by the U.S.S.R. 23%, and Norway 16%. The remaining 14% was by Canada, People's Republic of China, France, Italy, and Japan.

World producers of magnesium with annual capacities, processes, and plant locations are as follows:

Country	Company	Capacity (short tons)	Process	Plant location
Canada	Chromasco Corporation Limited	12,000	Silicothermic	Haley, Ontario.
China, People's Republic of	NA	5,000	do	Ying-kou, Liaoning.
France	Société Générale du Magnésium Péchiney Ugine Kuhlmann S.A. (70 percent). Société des Produits Azotés (SPA) (30 percent).	9,000	do	Marignac.
Italy	Societá Italiana per il Magnesio e Leghe di Magnesio.	7,700	do	Bolzano.
Japan	Furukawa Magnesium Company	7,700	do	Koyama.
	UBE Industries, Ltd	6,600	do	Yamaguchi.
Norway	Heroya Electrokemiske Fabrikker A/S subsidiary of Norsk Hydro-Elektrisk A/S	47,000	I. G. Farbenindustrie	Heroya.
U.S.S.R.	NA	50,000	Electrolytic	NA.
United States	American Magnesium Co	30,000	do	Snyder, Tex.
	The Dow Chemical Co	120,000	Dow cells	Freeport, Tex.
	NL Industries, Inc	45,000	Electrolytic	Rowley, Utah.

NA Not available.

Australia.—A research group at the University of Tasmania was investigating the feasibility of constructing a sea water magnesium facility in Australia. The main purpose of the study was to determine if all of Australia's magnesium requirements could be satisfied by a sea water magnesium plant.

India.—The Central Electrochemical Research Institute at Karaikudi started production from its magnesium pilot plant rated at 550 pounds of metal per day. A 10,000-ampere cell with a monthly capacity of 1.7 short tons was commissioned. The project was jointly sponsored by the Council of Scientific and Industrial Research and the Tamil Nadu Government. A larger scale plant with an annual capacity of 660 short tons employing the same process was scheduled for construction. The cost of production was estimated to be approximately equivalent to the price of imported magnesium.

The large reserves of magnesite at Salem and the considerable tonnages of sea bitterns to be produced at Tuticorin encouraged the Tamil Nadu Government to finance the project. The Research Institute developed a spray drier with a rated capacity to produce 155 pounds per hour

Table 7.—Magnesium: World production by country
(Short tons)

Country [1]	1970	1971	1972 [p]
Canada	10,353	7,234	5,844
China, People's Republic of [e]	1,100	1,100	1,100
France	5,083	7,954	[e] 7,700
Italy	8,356	8,496	[e] 8,300
Japan	11,395	10,685	12,004
Norway	38,959	39,799	40,224
U.S.S.R. [e]	55,000	57,000	60,000
United States	112,007	123,485	[2] 120,823
Total	[r] 242,253	255,753	255,995

[e] Estimate. [p] Preliminary. [r] Revised.
[1] The United Kingdom, listed among producers in previous editions, has been deleted because it was determined that the material credited to the United Kingdom subsequent to 1966 is entirely remelt alloy.
[2] Excludes two U.S. producers.

of partially anhydrous magnesium chloride from magnesium chloride solution. The metal production process involves the electrolysis of anhydrous magnesium chloride in a fused salt bath at 700° C.

Japan.—Mitsubishi Chemical Industries Co., Ltd., abandoned its plans to build a small electrolytic magnesium plant in Japan. The original plans had called for an electrolytic plant with an initial capacity of 5,000 tons per year of magnesium.

Netherlands.—Shell Minerals Netherlands NV (Shell) announced that it decided to postpone indefinitely its magnesium chloride project in the Friesland province of the country. Shell stated that it had suitable processing technology for magnesium, but that it was still too costly. Also, world prices for light metals, especially for aluminum, were depressed and that there was no prospect of a recovery in the near future.

The Netherlands Economics Ministry in The Hague said that Shell would not be given the production license it applied for 1½ years ago in view of the company's decision to shelve the project. The award had been delayed a number of times due to local opposition on environment-protection and pollution grounds.

The Economics Ministry added that, in view of the importance of the project for the economic development of the northern provinces of the Netherlands, it intended to set up an independent group to study other possibilities for exploiting the magnesium in the short term. Shell agreed to place the necessary technical information at the group's disposal.

Norway.—The Magnesium Division of Norsk Hydro A/S created a special 20-man technical staff to engage in technical marketing and to develop new applications for magnesium. The technical staff reported potential in the fields of alloying, electroplating, pressure die casting magnesium, and organic synthesis.

U.S.S.R.—The estimated production of magnesium metal in 1972 was 60,000 short tons, a 3,000-ton increase over 1971 production. According to the Soviet weekly ECOTASS, Russian magnesium exports reached 19,900 tons in 1972, a 34% increase compared with the 14,800 tons shipped in 1971.

TECHNOLOGY

The research laboratories of Alcoa developed a process whereby the magnesium content of aluminum scrap is reduced from about 0.5% to 0.1%.[2] Conventional methods to reduce the magnesium content of scrap produced chloride fumes. Alcoa's Fumeless Demagging Process, a pollution-free process, reportedly lowers operating costs and produces 99% pure magnesium chloride, a salable byproduct. The process involves the reaction of magnesium and chlorine by multiple-stage gas-liquid contacting in a closed reactor-settler tank, eliminating wet or dry scrubbers and dust filters. The operating costs are approximately one-third of those for chlorine fluxing and scrubbing systems. The capital cost is estimated at $75,000 for a system to remove magnesium from 24 million pounds per year of alloy scrap. The process is currently being installed at Alcoa's Davenport, Iowa, smelter where it will be used for in-plant wrought alloy scrap.

To prevent molten magnesium from oxidizing on contact with air, the molten metal is presently covered with a mixture of fine potassium and magnesium chloride powder. The Magnesium Research Center at Battelle Memorial Institute announced a $160,000 research program on the fluxless melting of magnesium which may possibly reduce the cost of casting magnesium by 4 cents per pound. Data from laboratory experiments as well as from commercial operations indicate that sulfur hexafluoride (SF_6) was a practical oxidation inhibitor for molten magnesium.[3] The optimum concentration of SF_6 in air for most efficient protection of molten magnesium is 1/10% or less.

Research by Bureau of Mines investigators showed that yields of vanadium in excess of 98% can be achieved by reducing

[2] Chemical Week. New Process That Solves Aluminum Can Recycling Problems. V. 111, No. 8, Aug. 23, 1972, p. 24.

[3] Hanawalt, J. D. Practical Protective Atmospheres for Molten Magnesium. Metals Engineering Quarterly, November 1972.

vanadium dichloride with magnesium.[4] The resultant vanadium metal product has a purity greater than 99.8%. The high efficiencies in the individual process steps indicated that vanadium produced with magnesium as the reductant has an excellent potential from an economic standpoint.

Other investigations by the Bureau of Mines demonstrated that nitrogen was an effective medium for quenching magnesium vapor produced in the carbothermic process.[5] Contrary to prior belief, the formation of magnesium nitride was not a major problem. For the carbothermic process to be cost competitive with the electrolytic process, large volumes of the quenching agent must be available at low cost. Nitrogen is available in abundant supply, and as a byproduct of oxygen production in steel and other metallurgical plants, should be relatively inexpensive.

According to the American Cast Iron Pipe Company (Acipco), Birmingham, Ala., magnesium-impregnated coke (Mag-Coke) is an effective desulfurizing agent for steel.[6] Acipco estimated that 1 pound of Mag-Coke would remove 0.018% of sulfur per ton of iron; the removal of 0.01% of sulfur per ton of iron would cost 25 to 30 cents. Spokesmen for several steel producers confirmed experimenting with Mag-Coke. Republic Steel Corp. reported that the use of Mag-Coke was beyond the research stage and was being used in regular iron production at its Warren, Ohio, and Gadsden, Ala., facilities.

---

[4] Campbell, T. T., J. L. Schaller, and F. E. Block. Preparation of High-Purity Vanadium by Magnesium Reduction of Vanadium Dichloride. Metallurgical Trans., v. 4, No. 1, January 1973, pp. 237–241.

[5] Dean, K. C., V. E. Edlund, and A. G. Lawrence. Quenching Carbothermic Magnesium With Nitrogen. Light Metal Age, v. 30, Nos. 5–6, June 1972, pp. 21–23.

[6] American Metal Market. Steelmakers Confirm Magnesium Used as Sulfur Removing Agent. V. 79, No. 113, June 16, 1972, p. 4.

Magnesium Compounds

By E. Chin [1]

World production of magnesite in 1972, excluding production in the United States, was estimated to be 9,764,474 short tons, a decrease of 2% from world production in 1971. Magnesite production in Austria, Czechoslovakia, North Korea, People's Republic of China, and the U.S.S.R. accounted for 71% of the total world output. The increase in the world production capacity for recovering magnesia from sea water, however, continued to exert competitive pressure on producers of magnesite.

Refractory magnesia and caustic-calcined and specified magnesias sold or used by domestic producers in 1972 were 9% above that sold or used in 1971. The value of domestic shipments of magnesias rose 10% to $76,187,000.

U.S. imports for consumption of processed magnesite were 133,734 tons; imports from Greece accounted for 58% of the 1972 total. Exports of magnesite and magnesia were 61,196 tons in 1972, and as in the 1970–71 period were primarily to Canada.

Table 1.—Salient magnesium compounds statistics

(Thousand short tons and thousand dollars)

	1968	1969	1970	1971	1972
United States:					
Caustic-calcined and specified magnesias:[1]					
Shipments:					
Quantity	119	125	122	127	128
Value	$17,958	$19,876	$19,301	$18,621	$15,856
Exports: [2]					
Value	$2,301	$2,687	$3,200	$2,840	$3,377
Imports for consumption: [2]					
Value	$758	$983	$702	$736	$675
Refractory magnesia:					
Sold and used by producers:					
Quantity	661	737	802	627	696
Value	$44,535	$51,843	$60,333	$50,359	$60,331
Exports:					
Value	$4,706	$4,973	$9,133	$5,897	$5,903
Imports:					
Value	$6,179	$5,913	$7,357	$9,219	$9,300
Dead-burned dolomite:					
Sold and used by producers:					
Quantity	1,833	1,866	1,373	1,020	1,125
Value	$31,627	$33,580	$25,740	$19,128	$21,097
World: Crude magnesite production:					
Quantity	11,781	10,627	9,763	9,975	9,764

[1] Excludes caustic-calcined magnesia used in production of refractory magnesia.
[2] Caustic-calcined magnesia only.

DOMESTIC PRODUCTION

In 1972, 909,428 short tons of magnesium hydroxide was produced from sea water and well brines. Output was by Barcroft Co., The Dow Chemical Company, Kaiser Aluminum & Chemical Corp., Merck & Co., Inc., and Michigan Chemical Corp. Most of the magnesium hydroxide was used in the production of magnesia for basic refractories. Producers of refractory magnesia were Basic Inc., Basic Magnesia, Inc., Corchem, Inc., A. P. Green Refractories, Co., Harbison-Walker Refractories Co., Kaiser Aluminum & Chemical Corp., Martin-Marietta Chemicals (formerly Stand-

[1] Physical scientist, Division of Nonferrous Metals.

ard Lime and Refractories Co.), and Northwest Magnesite Co. Total production of refractory magnesia in 1972 was 575,707 tons.

During the year, 189, 889 tons of caustic-calcined magnesia was produced by Basic Inc., Basic Magnesia, Inc., The Dow Chemical Company, Kaiser Aluminum & Chemical Corp., Martin-Marietta Chemicals, and Michigan Chemical Corp. Six companies produced 11,091 tons of specified magnesias.

Magnesium chloride was produced by American Magnesium Co., J. T. Baker Chemical Co., The Dow Chemical Co., FMC Corp., Great Salt Lake Minerals & Chemicals Corp., Kaiser Aluminum & Chemical Corp., Mallinckrodt Chemical Works, and NL Industries, Inc. Most of the magnesium chloride production was used for magnesium metal cell feed.

Production of magnesium sulfate was reported by four companies. Producers of other magnesium compounds were J. T. Baker Chemical Co., Mallinckrodt Chemical Works, Merck & Co., Inc., and Waverly Chemical Co., Inc.

Basic Magnesia, Inc., completed an expansion program at its sea water magnesia plant in Port St. Joe, Fla., with the installation of special material processing equipment, increased bagging capacity, and new bulk loading facilities for both trucks and railroad cars. Improvements were also made in the reaction system controls, which were designed to yield more uniform and higher quality oxides.

Table 2.—Dead-burned dolomite sold or used by producers in the United States

(Thousand short tons and thousand dollars)

Year	Sales of domestic product	
	Quantity	Value
1968	1,833	31,627
1969	1,866	33,580
1970	1,373	25,740
1971	1,020	19,128
1972	1,125	21,097

Domestic producers of magnesium compounds by raw material source, location, and annual capacity are listed as follows:

Raw material source and producing company	Location	Capacity (short tons MgO equivalent)
Magnesite:		
Basic Inc	Gabbs, Nev	150,000
Lake brines:		
Great Salt Lake Minerals & Chemicals Corp	Ogden, Utah	100,000
NL Industries, Inc	Rowley, Utah	75,000
Well brines:		
American Magnesium Co	Snyder, Tex	50,000
The Dow Chemical Co	Ludington, Mich	250,000
Martin Marietta Chemicals	Manistee, Mich	100,000
Michigan Chemical Corp	St. Louis, Mich	25,000
Morton Chemical Co	Manistee, Mich	5,000
Sea water:		
Basic Magnesia, Inc	Port St. Joe, Fla	100,000
Barcroft Co	Lewes, Del	5,000
Corchem, Inc	Pascagoula, Miss	40,000
The Dow Chemical Co	Freeport, Tex	250,000
FMC Corp	Chula Vista, Calif	5,000
Kaiser Aluminum & Chemical Corp	Moss Landing, Calif	150,000
Merck & Co., Inc	South San Francisco, Calif	5,000
Northwest Magnesite Co	Cape May, N.J	100,000
Total		1,410,000

CONSUMPTION AND USES

In 1972, 696,102 tons of magnesia was used in the production of basic refractories, compared with 626,513 tons in 1971. Consumption of caustic-calcined magnesia for uses other than the production of refractory magnesia included chemical processing, animal feed, pulp and paper, rayon, and sugar. Specified magnesias were used primarily in electrical, medicinal, and rubber applications.

Olivine was consumed as a molding sand in various foundries and as a metallurgical flux in the smelting of steel.

Magnesium chloride was used as an antifreeze agent and in the processing of molasses. Magnesium carbonate was consumed in the production of cosmetics and pharmaceuticals.

Table 3.—Magnesium compounds shipped and used in the United States

Year and product	Plants	Shipped and used: Quantity (short tons)	Shipped and used: Value (thousands)
1971			
Caustic-calcined [1] and specified (U.S.P. and technical) magnesias	12	r 126,722	r $18,621
Refractory magnesia [2]	9	r 626,513	r 50,359
Magnesium hydroxide (100 percent $Mg(OH)_2$) [1]	9	71,366	r 2,030
Magnesium chloride [3]	8	575,674	r 35,744
Precipitated magnesium carbonate [1]	6	5,510	r 1,251
1972			
Caustic-calcined [1] and specified (U.S.P. and technical) magnesias	11	128,260	$15,856
Refractory magnesia [2]	8	696,102	60,331
Magnesium hydroxide (100 percent $Mg(OH)_2$) [1]	10	66,671	2,454
Magnesium chloride [3]	9	559,709	36,202
Precipitated magnesium carbonate [1]	5	5,074	1,476

r Revised.
[1] Excludes material produced as an intermediate step in the manufacture of other magnesium compounds.
[2] Includes both single-burned and double-burned.
[3] Production for 1971, 827,486; 1972, 951,220; includes magnesium chloride used in the production of magnesium metal.

Table 4.—Domestic shipments of caustic-calcined and specified magnesias, by use

(Short tons)

Use	1971	1972
Agriculture, nutrition, and pharmaceuticals:		
Animal feed and fertilizer	18,406	23,498
Medicinals	6,319	W
Sugar, candy, and winemaking	3,186	4,532
Total	27,911	28,030
Construction materials:		
Insulation and wallboard	W	W
Oxychloride and oxysulfate cement	13,248	17,315
Total	13,248	17,315
Chemical processing, manufacturing, and metallurgical:		
Chemicals	25,873	33,831
Electrical heating rods	704	2,364
Flux	W	W
Petroleum additive	W	W
Pulp and paper	14,612	15,312
Rayon	15,167	W
Rubber	3,704	7,411
Uranium processing	W	W
Water treatment	1,428	W
Total	62,508	72,712
Unspecified uses	23,055	10,203
Grand total	126,722	128,260

W Withheld to avoid disclosing individual company confidential data; included with "Total."

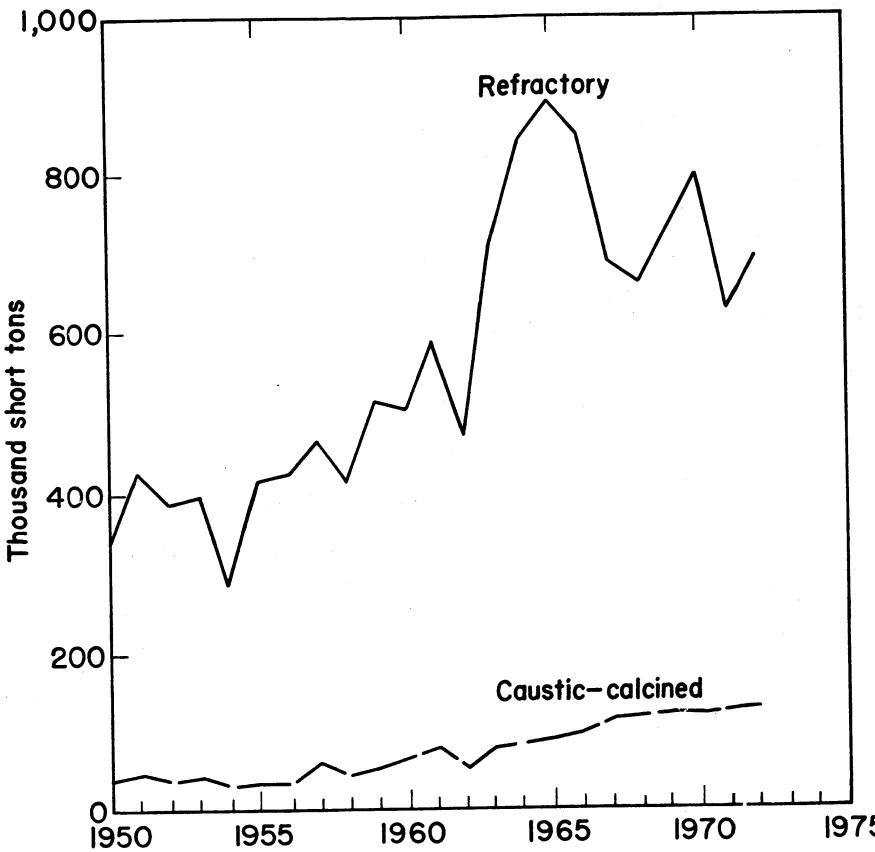

Figure 1.—Consumption and shipments of magnesia in the United States.

PRICES

Prices for magnesia, calcined, technical, heavy, 85% and 90% (bags, carlot, f.o.b. Luning, Nev.) were quoted during the year at $50 and $60 per short ton, respectively according to the Chemical Marketing Reporter. Magnesia, technical, synthetic rubber-grade, neoprene-grade, light, was quoted with no change from the 1971 price at $0.24 per pound (bags, carlot, freight-equalized).

Prices throughout the year for magnesium carbonate, technical (bags, carlot, freight-equalized), remained the same as in 1971 at $0.16 per pound; for truckload quantities prices remained at $0.18 to $0.185 per pound. During the year the price for magnesium hydroxide, NF, powder (drums, carlot, and truckload, works) ranged from $0.21 to $0.295 per pound. Magnesium chloride, hydrous, 99%, flakes, bags, carlot, works, was quoted at $72.80 per ton. The price for magnesium lauryl sulfate, tanks, freight-allowed, remained the same as in 1971 at $0.175 per pound.

FOREIGN TRADE

Exports of dead-burned magnesite and magnesia in 1972 totaled 54,159 tons compared with 53,448 tons in 1971. Exports to Canada in 1972 were 51,694 tons, 21%

higher than in 1971. However, shipments to Mexico, Peru, and Spain in 1972 were substantially lower than those of 1971.

Exports of magnesite, including crude, caustic-calcined, lump or ground, decreased slightly from exports in 1971. Deliveries to West Germany, Canada, Italy, the United Kingdom, and Australia accounted for over 50% of the exports in this class.

Imports for consumption of lump or ground caustic-calcined magnesia decreased 10% in 1972 to 10,376 tons. Imports in this class were principally from India and Turkey.

Imports of dead-burned and grain magnesia and periclase containing a maximum of 4% lime increased 10% to 127,776 tons in 1972. Imports for the same class of material but containing over 4% lime decreased from 13,146 tons in 1971 to 5,958 tons in 1972. Total imports of magnesite increased 4% over those in 1971 to 133,734 tons.

Imports of unspecified magnesium chloride, magnesium sulfate, and magnesium salts and compounds decreased substantially in 1972 compared to imports in these classes in 1971. Imports of precipitated magnesium carbonate and magnesium oxide increased slightly over those in 1971.

The tariff on various magnesium compounds was as follows:

Item	1971	1972
Magnesite:		
Crude per ton	$3.15	$2.62
Caustic-calcined do	$6.30	$5.25
Magnesium carbonate:		
Precipitated cents per pound	0.25	0.25
Not precipitated-% valorem	5%	4%
Magnesium chloride:		
Anhydrous cents per pound	.6	.5
Other do	.25	.21
Magnesium oxide:		
Calcined magnesia do	1.2	1
Magnesium sulfate:		
Epsom salts do	.225	.187

Table 5.—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			
	1971		1972		1971		1972	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Argentina	330	$49	774	$115	80	$34	113	$51
Australia	120	68	20	9	450	254	442	237
Belgium-Luxembourg	--	--	--	--	107	44	87	36
Brazil	28	7	11	6	52	24	122	57
Canada	40,586	4,040	51,694	5,064	893	360	1,105	486
Chile	975	97	329	22	121	32	75	23
Colombia	--	--	--	--	12	6	19	10
Costa Rica	--	--	--	--	262	27	1	(1)
Denmark	--	--	--	--	34	19	28	17
El Salvador	5	1	5	1	550	55	--	--
Finland	--	--	6	4	89	35	181	100
France	62	9	50	5	274	103	342	209
Germany, West	157	81	180	98	890	445	1,269	598
Honduras	56	8	--	--	--	--	25	4
Israel	--	--	--	--	27	14	29	15
Italy	--	--	18	15	592	258	701	332
Japan	44	27	55	39	47	13	26	14
Mexico	5,679	569	7	4	102	19	78	22
Netherlands	50	7	48	17	264	87	182	72
New Zealand	36	23	32	21	116	67	125	81
Peru	1,667	154	--	--	5	2	12	6
Philippines	3	1	27	7	105	33	5	3
South Africa, Republic of	81	52	104	75	314	174	200	94
Spain	2,432	224	1	(1)	281	82	151	63
Sweden	76	42	72	50	310	212	362	262
Switzerland	--	--	16	3	62	22	51	20
Taiwan	--	--	--	--	--	--	168	52
U.S.S.R.	--	--	--	--	--	--	54	42
United Kingdom	718	397	566	321	755	318	634	297
Venezuela	305	32	50	7	66	14	154	20
Yugoslavia	--	--	--	--	11	7	80	53
Other	38	9	94	20	179	80	216	101
Total	53,448	5,897	54,159	5,903	7,050	2,840	7,037	3,377

[1] Less than ½ unit.

Table 6.—U.S. imports for consumption of crude [1] and processed magnesite, by country

Country	1971 Quantity (short tons)	1971 Value (thousands)	1972 Quantity (short tons)	1972 Value (thousands)
Lump or ground caustic-calcined magnesia:				
Australia	498	$52	231	$27
Austria	561	24	520	19
Belgium-Luxembourg	6	1	--	--
Greece	426	34	917	82
India	7,848	458	6,711	378
Netherlands	177	15	222	20
New Zealand	162	17	--	--
Turkey	1,840	135	1,775	149
Total	11,518	736	10,376	675
Dead-burned and grain magnesia and periclase:				
Not containing lime or not over 4% lime:				
Australia	60	5	964	96
Austria	6,761	448	8,323	526
Canada	149	9	112	12
Germany, West	--	--	6	3
Greece	76,267	6,392	76,921	5,360
Ireland	26,616	1,967	24,827	2,004
Italy	--	--	3	(2)
Japan	6,009	362	5,434	364
Mexico	--	--	3	(2)
Poland	--	--	5,616	468
United Kingdom	17	36	5,556	466
Yugoslavia	--	--	11	1
Total	115,879	9,219	127,776	9,300
Containing over 4% lime:				
Austria	2,408	138	2,717	163
Canada	2,417	165	3,208	230
Spain	2,927	151	--	--
Yugoslavia	5,394	341	33	2
Total	13,146	795	5,958	395
Grand total	129,025	10,014	133,734	9,695

[1] Crude magnesite 1971, 7 S.T. ($303); 1972, none.
[2] Less than ½ unit.

Table 7.—U.S. imports for consumption of magnesium compounds

Year	Oxide or calcined magnesia Quantity (short tons)	Oxide or calcined magnesia Value (thousands)	Magnesium carbonate (precipitated) Quantity (short tons)	Magnesium carbonate (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)	Magnesium sulfate (epsom salts and kieserite) Quantity (short tons)	Magnesium sulfate (epsom salts and kieserite) Value (thousands)	Magnesium salts and compounds n.s.p.f.[1] Quantity (short tons)	Magnesium salts and compounds n.s.p.f.[1] Value (thousands)
1970	521	$200	808	$192	--	--	824	$26	34,939	$617	3,608	$327
1971	628	222	138	60	26	$2	435	15	45,597	654	2,889	304
1972	690	256	139	73	22	1	250	8	21,538	378	2,662	395

[1] Not specifically provided for; includes magnesium silicofluoride or fluosilicate and calcined magnesia.

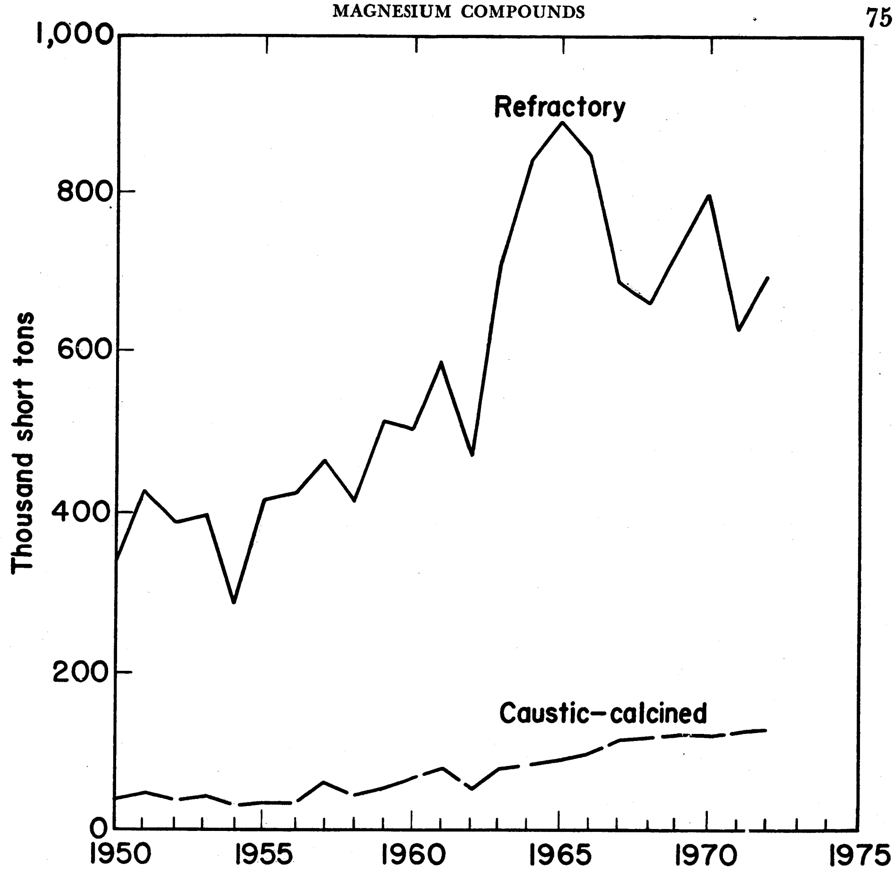

Figure 2.—Value of U.S. exports and imports of magnesia.

WORLD REVIEW

Germany, West.—Magnesital-Feuerfest G.m.b.H. initiated construction of its $10 million refractory plant at Oberhausen in the Duisburg area of the Ruhr District. Magnesital-Feuerfest is a joint venture of Dresser Industries, Inc., and Martin & Pagenstecher G.m.b.H., a West German refractories producer. The plant is being built in two phases. The first phase, which calls for the manufacture of high-alumina specialty refractories, is expected to be completed in early 1973. The second phase, for the manufacture of high-quality magnesia refractories used primarily in basic oxygen steelmaking processes, is scheduled to be completed and in operation by December 1973.

Greece.—Société Financière de Grèce (Scalistiri), the largest producer of magnesite in Greece, completed construction of a new loading jetty at Mantoudi, Northern Euboea. With the new jetty, magnesite can be loaded at a rate of 1,000 tons per hour. Other additions such as new silos and a belt conveyor were planned by mid-1973.

India.—Almora Magnesite Ltd. was installing a magnesite processing plant near Almora, Uttar Pradesh. Expected completion date for the construction was the fall of 1973. The plant was expected to produce 100,000 tons of dead-burned magnesite per year. Almora was owned 51% by the UP State Industrial Corp. and 49% by Belpahar Refractories Ltd.

Italy.—Compagnia Generale de Magnesio S.p.A. continued the construction of its 60,000 ton per year sea water magnesia plant near Syracuse, Sicily. Construction of the plant began in August 1971, and at the end of 1972 was nearing completion. Initial production of chemical and refractory magnesia was scheduled for late 1973. High-purity limestone deposits are available at the site and will probably permit an increase of the magnesium oxide content of the magnesia produced at the plant to over 98%.

Netherlands.—Shell Internationale Petroleum Maatschaapij installed a high-pressure water heater at its magnesium salt recovery pilot plant on the Friesian coast. Although fitted with an air atomizing burner for use with oil, the dual fuel heater was fired on natural gas and can handle a water flow of 66,000 pounds per hour.

Tanzania.—The National Development Corp. (NDC) of the Tanzanian Government planned to invest between $280,000 and $344,000 to revive and expand magnesite mining near Samé. This mine was formerly operated by the Tanganyika Magnesite Mines, Ltd. The NDC expected to establish a 24,000-ton-per-year magnesite plant by 1974 and to continue operations for 15 to 20 years on the basis of reserves which have been estimated to be between 1 million and 4 million tons.

United Kingdom.—Steetley Co., Ltd., commissioned a new plant at its Hartlepool works for the production of chemical-grade magnesia. The new plant included a gas-fired, multiple-hearth furnace equipped with special burners designed by Steetley's Central Research Laboratories. The design and instrumentation of the furnace reportedly allowed close control of burning conditions, which permitted a high degree of flexibility in achieving precise physical and chemical specifications, tailored to meet customer requirements.

Yugoslavia.—The state-owned refractory materials producing complex, Magnohrom, announced a $30 million expansion and modernization program of its mining and manufacturing plants at Kraljevo. The expansion program, to be completed by 1975, was expected to increase the present production of 100,000 tons of magnesite brick to 160,000 tons per year, and to increase the production of refractory materials for the steel industry from 4,000 tons to 40,000 tons per year. Plans for the country's first magnesium metal producing facilities were included in the project.

Table 8.—Magnesite: World production by country [1]

(Short tons)

Country	1970	1971	1972 p
North America: United States	W	W	W
South America:			
Brazil e	260,000	296,000	e 300,000
Mexico	r 7,635	14,350	e 15,000
Europe:			
Austria	1,773,992	1,715,700	1,575,660
Czechoslovakia	r 695,768	r 682,288	e 680,000
Greece	832,438	995,064	e 990,000
Poland e	55,000	55,000	55,000
Spain	r 245,203	e 250,000	e 250,000
U.S.S.R. e	1,569,000	r 1,600,000	1,650,000
Yugoslavia	r 564,221	543,126	465,000
Africa:			
Kenya	4	244	e 250
Rhodesia, Southern e	20,000	22,000	22,000
South Africa, Republic of	92,874	86,711	75,830
Sudan	110	e 110	e 110
Tanzania	r 761	1,103	e 1,100
Asia:			
China, People's Republic of e	1,100,000	1,100,000	1,100,000
India	384,664	329,800	301,000
Iran [2]	22,000	23,000	e 23,000
Korea, North e	1,800,000	1,900,000	1,900,000
Pakistan	r 513	239	324
Turkey	313,946	339,306	e 340,000
Oceania:			
Australia	24,759	19,943	e 19,000
New Zealand	534	1,154	e 1,200
Total	9,763,422	9,975,138	9,764,474

e Estimate. p Preliminary. r Revised.
W Withheld to avoid disclosing individual company confidential data.
[1] Figures presented are crude salable magnesite. In addition to the countries listed, Bulgaria, Canada, and Colombia produce magnesite, but output is not reported, and available information is inadequate to make reliable estimates of output levels.
[2] Year beginning March 21 of that stated.

World sea water magnesia production facilities by company and annual capacity are as follows:

Country	Location	Company	Capacity (short tons 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.[1]	60,000
	Sant'Antioco, Sardinia	Sardamag S.p.A	120,000
	Hotsu	Hokuriku Seien K.K	35,000
Japan	Navetsu	Nihon Kasui Kako	120,000
	Minamata, Onohama, Toyama	Shin-Nihon Chemical Industries Co	170,000
	Ube, Yamaguchi	Ube Chemical Industries Co., Ltd	420,000
Mexico	Ciudad Madero, Tampico	Quimica del Mar SA	50,000
Norway	Heroya, Oslo Fjord	Norsk Hydro-Elektrisk Kvaelstof A/S.	80,000
U.S.S.R	NA		100,000
United Kingdom	Hartlepool County, Durham	Steetley, Ltd	250,000
United States	(2)		660,000
Total			2,220,000

NA Not available.
[1] Under construction.
[2] Sea water production facilities appear in tabulation shown in "Domestic Production" section of this chapter.

TECHNOLOGY

The Philadelphia Electric Company is installing a prototype system to absorb sulfur dioxide from flue gas with magnesium oxide.[2] The system will be in operation in late 1973 and will be the first of its kind installed on a coal-fired unit. The total cost of the facilities will be approximately $15 million.

The Potomac Electric Power Company planned to install a prototype system also to absorb sulfur dioxide from flue gas with magnesium oxide using a process developed by Chemical Construction Company and Basic Chemicals of Cleveland.[3] This plant will not probably be in operation before 1975. The approximate cost of the facilities will be about $6 million.

New methods to beneficiate domestic olivine for foundry sand applications were investigated.[4] A disadvantage of calcining olivine in conventional rotary kiln or fluid-type calciners is partial oxidation of ferrous oxide, which is undesirable in foundry sands. A laboratory tube-type furnace, making use of the free-flowing properties of olivine sand, was designed for continuous calcining. Utilizing this technique, high-quality foundry sand could be produced from olivine by calcining under nonoxidizing conditions.

A report on the refractory magnesia industry in Canada was published by the Mines Branch of the Department of Energy, Mines, and Resources.[5] The review included information on the occurrence of magnesite, current commercial exploitation of magnesite, and sea water magnesia in Canada. An article was published summarizing the development work leading to the analysis of periclase products by atomic absorption.[6] Test results showed that agreement between atomic absorption and wet chemical methods for calcium oxide, silica, iron and alumina were good. It was concluded that atomic absorption methods were suitable for quality control analyses of periclase grain containing greater than 95% MgO.

[2] Assessment of the State-of-Technology of Air Pollution Control Equipment and of the Impact of Clean Air Regulations on the Adequacy of Electric Power Supply of North America Bulk Power Systems. National Electric Reliability Council, Appendix G, October 1972.
[3] Gas Scrubber for Pepco. The Washington Daily News. No. 51, Jan. 5, 1972, p. 22.
[4] Bedeker, Immo H. Beneficiation of Olivine for Foundry Sand by Calcining. Minerals Research Laboratory, Report No. MRL-2, North Carolina State Univ., August 1972. 17 pp.
[5] Palfreyman, M. Refractory-Grade Magnesia in Canada. Tech. Bull., TB 163, November 1972.
[6] Werner, Glen E. Analysis of Periclase by Atomic Absorption (AA). Prize Winning Papers in the 1972 Award Contest for the Best Papers on any Phase of Refractories. April 13–14, 1972, pp. 21–30; available from The Refractories Institute, 3154 One Oliver Plaza, Pittsburgh, Pa. 15222.

Manganese

By Gilbert L. DeHuff[1]

There was no actual production of manganese ore, concentrate, or nodules, containing 35% or more manganese, in the United States in 1972, but a small quantity of manganese nodules continued to be shipped from stocks. Imports of managanese ferroalloys and metal were at a high rate, and domestic producers continued to be faced with the problems of pollution control and adequate availability of power. Plans were underway for substantial new capacity for production of electrolytic manganese metal in the Republic of South Africa.

Table 1.—Salient manganese statistics in the United States

(Short tons)

	1968	1969	1970	1971	1972
Manganese ore (35% or more Mn):					
Production (shipments):					
Metallurgical	10,536	5,630	4,737	142	578
Battery	842	--	--	--	--
Total	11,378	5,630	4,737	142	578
Imports general	1,827,626	1,959,661	1,735,055	1,914,264	1,620,252
Consumption	2,228,412	2,181,333	2,363,937	2,155,454	2,331,459
Manganiferous ore (5% to 35% Mn):					
Production (shipments)	244,590	430,637	368,302	198,334	147,161
Ferromanganese:					
Production	879,962	852,019	835,463	759,896	800,723
Exports	3,710	1,759	21,747	4,526	6,842
Imports for consumption	203,212	307,891	290,946	242,778	348,539
Consumption	1,016,559	1,071,042	1,000,611	899,011	967,968

Legislation and Government Programs.—Under the provisions of the Strategic and Critical Materials Stock Piling Act, as amended (Public Law 520, 79th Congress) the Office of Emergency Preparedness redetermined the following manganese items to be strategic and critical: Natural battery manganese ore, battery-grade synthetic manganese dioxide, type A chemical-grade manganese ore, type B chemical-grade manganese ore, metallurgical manganese ore, high-carbon ferromanganese, medium-carbon ferromanganese, low-carbon ferromanganese, silicomanganese, and electrolytic manganese metal.

Sales of surplus metallurgical ore in calendar year 1972 totaled 1,243,744 short dry tons. These sales were on a negotiated basis with deliveries limited. Sales of surplus synthetic manganese dioxide in the calendar year were 1,278 short dry tons, all on a competitive sealed-bid basis. No acceptable bids were received in response to a General Services Administration (GSA) offering of surplus natural battery-grade ore, or to its offerings of surplus chemical-grade ore, types A or B.

Manganese stockpile inventory changes in the calendar year consisted of the following:Metallurgical ore, stockpile grade, decreased 490,705 short tons to 7,672,536 tons; metallurgical ore, non-stockpile grade, decreased 2,800 tons to 1,389,771 tons; synthetic dioxide decreased 2,619 tons to 17,019 tons; and stockpile-grade natural battery ore decreased 45 tons to 253,451 tons.

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

DOMESTIC PRODUCTION

Except for a small quantity of metallurgical oxide nodules shipped from stocks by The Anaconda Company, and made several years ago from Montana carbonate ore, there was neither production nor shipment of manganese ore, concentrates, or nodules in the United States in 1972.

Ferruginous manganese ores or concentrates containing 10% to 35% manganese were produced and shipped from New Mexico, and shipments continued from the Cuyuna Range of Minnesota. Manganiferous iron ore containing 5% to 10% manganese was neither produced nor shipped in either 1972 or 1971. Manganiferous zinc residuum continued to be produced from New Jersey zinc ores.

Table 2.—Manganese and manganiferous ore shipped[1] in the United States, by State

(Short tons)

Type and State	1971		1972	
	Gross weight	Manganese content	Gross weight	Manganese content
Manganese ore (35% or more Mn, natural): Montana	142	75	578	305
Total	142	75	578	305
Manganiferous ore:				
Ferruginous manganese ore (10% to 35% Mn, natural):				
Minnesota	169,732	23,005	119,324	15,081
New Mexico	28,490	3,504	27,837	3,646
Utah	112	37	--	--
Total	198,334	26,546	147,161	18,727
Manganiferous iron ore (5% to 10% Mn, natural)	--	--	--	--
Total manganiferous ore	198,334	26,546	147,161	18,727
Value manganese and manganiferous ore	$1,468,000	--	$1,040,000	--

[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.

CONSUMPTION, USES, AND STOCKS

In the production of raw steel (ingots, continous- or pressure-cast blooms, billets, slabs, etc., and including steel castings), consumption of manganese as ferroalloys, metal, and direct-charged ore was 12.6 pounds per short ton of raw steel produced. Of this total, 11.0 pounds was ferromanganese; 1.2 pounds, silicomanganese; 0.05 pound, spiegeleisen; 0.25 pound, manganese metal; and 0.1 pound, manganese ore. The comparable 1971 total, on the same basis, was 13.0 pounds with ferromanganese at 11.2, silicomanganese at 1.3, spiegeleisen at 0.05, metal at 0.25, and ore at 0.2. It should perhaps be observed that, in addition to the above consumption of manganese in 1972, there was consumed per short ton of raw steel produced approximately 1.2 pounds of manganese contained in manganese ore used in making pig iron. In 1971, the quantity was approximately 1.0 pound. This increase in the use of manganese ore (containing more than 35% manganese) as blast furnace feed has been apparent since 1969.

Manganese ferroalloy producers proceeded with their air and water pollution control programs, completion of which will tend to aggravate already existing problems of adequate power supply.

Electrolytic Manganese and Manganese Metal.—All of the manganese metal produced in the United States was electrolytic manganese metal, and it is certain that virtually all of that imported was electrolytic metal. Virtually all of the metal consumed was electrolytic metal, but it is possible that some low-carbon ferromanganese, and possibly some manganese-aluminum additives, may have been erroneously reported by consumers as manganese metal. Production of electrolytic metal in 1972 was 23,200 short tons, compared with 20,475 tons in 1971, and was by the same

Table 3.—Consumption and industry stocks of manganese ore [1] in the United States

(Short tons)

	Consumption 1971	Consumption 1972	Stocks Dec. 31, 1972
By use:			
Manganese alloys and metal	1,837,683	1,925,715	1,382,747
Pig iron and steel	187,251	211,157	131,580
Dry cells, chemicals and miscellaneous	130,520	194,587	280,460
Total	2,155,454	2,331,459	1,794,787
By origin:			
Domestic	28,316	39,628	11,846
Foreign	2,127,138	2,291,831	1,782,941
Total	2,155,454	2,331,459	1,794,787

[1] Containing 35 percent or more manganese (natural).

Table 4.—Consumption, by end use, and industry stocks of manganese ferroalloys and metal in the United States, in 1972

(Short tons, gross weight)

End use	Ferromanganese High carbon	Ferromanganese Medium and low carbon	Silico-manganese	Spiegel-eisen	Manganese metal [1]
Steel:					
Carbon	659,872	99,424	71,067	9,871	7,078
Stainless and heat resisting	4,197	5,292	8,371	--	6,483
Full alloy	76,729	26,496	26,682	1,141	1,216
High-strength low-alloy	59,445	8,254	6,544	141	375
Electric	326	204	817	--	8
Tool	1,175	222	27	--	676
Cast irons	16,231	1,986	3,660	8,461	23
Superalloys	220	90	W	--	338
Alloys (excludes alloy steels and superalloys)	4,608	1,180	2,393	4	12,685
Miscellaneous and unspecified	989	1,028	4,692	2	1,067
Total	823,792	144,176	124,253	19,620	29,949
Stocks December 31	368,214	36,292	54,024	13,217	6,704

W Withheld to avoid disclosing individual company confidential data; included in "Miscellaneous and unspecified."

[1] Virtually all electrolytic.

three companies: Foote Mineral Co., New Johnsonville, Tenn.; Kerr-McGee Chemical Corp., Hamilton, (Aberdeen), Miss.; and Union Carbide Corp., Marietta, Ohio.

Ferromanganese.—Bethlehem Steel Co. and U.S. Steel Corp. continued to be the only domestic ferromanganese producers using blast furnaces: Bethlehem at Johnstown, Pa.; U.S. Steel in the Pittsburgh district at Clairton and McKeesport, Pa. Electric furnaces were used to produce ferromanganese by the same 6 companies in the same 10 plants as in 1971: Airco Alloys and Carbide Div., Airco, Inc., Calvert City, Ky., and Theodore (Mobile), Ala.; Chromium Mining & Smelting Corp., Woodstock (Memphis), Tenn.; Ohio Ferro-Alloys Corp., Philo, Ohio; Roane Electric Furnace Division of Woodward Corp., a Division of Mead Corp., Rockwood, Tenn.; Tenn-Tex Alloy Corporation of Houston, Houston, Tex.; and Union Carbide Corp., Ferroalloys Div., Alloy, W. Va., Ashtabula and Marietta, Ohio, and Portland, Oreg. Fused salt electrolysis continued to be used by Chemetals Division, Diamond Shamrock Chemical Co., Kingwood, W. Va., to make low-carbon ferromanganese sold under the trade name of Massive Manganese. U.S. shipments of ferromanganese totaled 727,000 short tons, compared with 800,000 tons in 1971.

Silicomanganese.—Production of silicomanganese in the United States was 153,000 short tons, compared with 165,000 tons in 1971. Shipments from furnaces totaled 146,000 tons, compared with 144,000 tons in 1971. In 1972, 7 companies utilized 11 plants to make silicomanganese: Airco Alloys and Carbide Div., Airco, Inc., Calvert City, Ky., and Theodore (Mobile), Ala.; Chromium Mining & Smelting Corp., Woodstock (Memphis), Tenn.; Interlake Inc., Beverly, Ohio; Ohio Ferro-Alloys Corp., Philo, Ohio; Roane Electric Furnace Division of Woodward Corp., a Division of Mead Corp., Rockwood, Tenn.; Tenn-Tex Alloy Corporation of Houston, Houston, Tex.; and Union Carbide Corp., Alloy, W. Va., Ashtabula and Marietta, Ohio, and Portland, Oreg. Consumption of silicomanganese was 12.8% that of ferromanganese, compared with 13.7% in 1971. This continues a steady drop from the recorded high of 18.5% in 1965. Because much of the use of silicomanganese has been for blocking (immediate stoppage of oxidizing action) the open-hearth heat, and blocking is not practiced with the basic oxygen furnace (BOF), this decrease in the ratio of silicomanganese consumption to ferromanganese consumption can probably be attributed in large part to the steadily increasing displacement of the open-hearth by the BOF.

Spiegeleisen.—The New Jersey Zinc Co. continued to produce spiegeleisen solely by electric furnaces at Palmerton, Pa.

Table 5.—Ferromanganese produced in the United States and manganese ore [1] consumed in its manufacture

Year	Ferromanganese produced			Manganese ore [1] consumed (short tons)		
	Gross weight (short tons)	Manganese content		Gross weight [2]		Per ton of ferromanganese [3] made
		Percent	Short tons	Foreign	Domestic	
1968	879,962	78.0	686,370	2,013,360	15,207	2.3
1969	852,019	77.3	658,837	1,992,671	8,064	2.3
1970	835,463	78.5	655,436	2,098,210	1,216	2.4
1971	759,896	78.6	597,205	1,820,408	7,033	2.4
1972	800,723	78.3	627,358	1,896,483	25,620	2.3

[1] Containing 35% or more manganese (natural).
[2] Includes ore used in producing silicomanganese and metal.
[3] Includes ore used in producing silicomanganese.

Table 6.—Manganese ore used in producing ferromanganese, silicomanganese, and manganese metal in the United States in 1972, by source of ore

Source	Gross weight (short tons)	Mn content, natural (%)
Domestic [1]	25,620	49
Foreign:		
Africa	823,315	48
Australia	123,926	48
Brazil	643,341	49
India	148,029	43
Mexico	76,314	38
U.S.S.R.[1]	12,523	50
Other or unidentified	69,035	--
Total	1,922,103	48

[1] From U.S. Government surplus stockpile disposals, except for possibly a small tonnage of domestic ore.

Pig Iron.—A total of 434,000 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 244,000 tons, of which 219,000 tons was manganiferous iron ore containing 5% to 10% manganese, 25,000 tons was ferruginous manganese ore containing 10% to 35% manganese, and 900 tons contained more than 35% manganese. Foreign sources supplied 190,000 tons, of which 5,000 tons was manganiferous iron ore, and 185,000 tons contained more than 35% 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 battery, premium or heavy-duty Leclanché cells, and as a blend with natural ore in the ordinary Leclanché (manganese dioxide-ammonium chloride-zinc) cell.

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.

In October, C-E Minerals, a division of Combustion Engineering, Inc., closed its Lynchburg, Va., manganese ore grinding plant. The product was used largely for the manufacture of face brick. The equipment was transferred to the Camden, N.J., plant where similar operations continued to be conducted. The company's Brownsville, Tex., and Wilmington, Del., plants also continued to grind imported manganese ores for the same purpose.

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 shipping rates. In March, the American Metal Market dropped its price quotation for manganese ore containing 46% to 48% manganese from 59 to 63 cents, nominal, to 58 to 61 cents, nominal, per long ton unit, c.i.f. eastern seaboard and Gulf ports. The quotation for ore containing 48% to 50% manganese was lowered at the same time from 63 to 68 cents, nominal, to 61 to 64 cents, nominal, same basis. Both of the new quotations were maintained for the remainder of the year.

Manganese Alloys.—The domestic producer price for standard high-carbon ferromanganese having a minimum manganese content of 78% remained at $190 per long ton, f.o.b. producer plant or shipping point. Contract sales in quantity apparently were at lower prices to be competitive with imported alloy. Metals Week continued to quote the 74% to 76% manganese grade of imported standard high-carbon ferromanganese at $176 to $178 per long ton of alloy, delivered in Pittsburgh or Chicago, until April. Stating that few consumers continue to use that grade, the paper changed the quotation then to $178 to $180 for standard alloy containing 78% manganese.

Manganese Metal.—The price of standard electrolytic manganese metal again remained unchanged for another full year at 33.25 cents per pound, f.o.b. producer plant, for shipments of 30,000 pounds or more.

FOREIGN TRADE

Exports of ferromanganese were 6,842 short tons valued at $1,511,864, compared with 4,526 tons valued at $1,204,819 in 1971. Of the 1972 total, Canada took 2,956 tons; Sweden, 2,392 tons; Mexico, 1,322 tons; Colombia, 65 tons; France, 51 tons; and small quantities went to each of nine other countries. Exports classified as "manganese and manganese alloys, wrought or unwrought, and waste and scrap" totaled 1,504 tons valued at $1,020,743 in 1972, and 1,203 tons valued at $911,785 in 1971. 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 totaled 25,108 short tons at a value of $3,137,104, compared with 55,413 tons at $2,683,070 in 1971. The 1972 exports were believed to consist almost entirely of imported manganese dioxide ore exported after grinding, blending, or otherwise classifying.

The average grade of imported manganese ore was 49% manganese in both 1972 and 1971. More than half of the total continued to come from Gabon and Brazil. There were no imports of manganiferous ores containing more than 10% but less than 35% manganese.

Ferromanganese imports for consumption were the highest on record. However, a good portion of the 1972 total came from foreign companies in which United States producers or consumers have substantial interest. Silicomanganese imports for consumption totaled 38,674 short tons containing 25,901 tons of manganese. Sources and tonnage (gross weight) were as follows: Norway, 26,801; Mexico, 4,364; Spain, 2,536; Yugoslavia, 2,162; Japan, 1,653; Sweden, 551; France, 336; and West Germany, 271. Imports for consumption classified as unwrought manganese metal, except alloys, and waste and scrap of such metal, totaled 4,121 short tons, compared with 2,870 tons in 1971. Of the 1972 quantity, 2,375 tons came from Japan, 1,639 tons from the Republic of South Africa, 105 tons from the Netherlands, and 2 tons from Canada. A small quantity, 5 pounds having a value of $117 per pound, came from Switzerland.

Imports for consumption classified as "manganese compounds, other" totaled 7,937 short tons in 1972, compared with 2,942 tons in 1971. The sources, gross weights, and values per pound in 1972 were as follows: Japan, 4,126 tons (17.5 cents); Morocco, 3,307 tons (1.7 cents); the United Kingdom, 279 (6.9 cents); Belgium-Luxembourg, 218 tons (16.0 cents); the Republic of South Africa, 5 tons (6.7 cents); and West Germany, 2 tons (82 cents). The imports from Japan and Belgium-Luxembourg appear to have consisted largely, if not entirely, of synthetic manganese dioxide.

Table 7.—U.S. imports[1] of manganese ore (35% or more Mn), by country

Country	1971			1972		
	Gross weight (short tons)	Mn content (short tons)	Value (thousands)	Gross weight (short tons)	Mn content (short tons)	Value (thousands)
Angola[2]	56,721	27,603	$982	35,570	17,160	$1,244
Australia	107,593	52,630	2,629	82,587	40,261	1,575
Brazil	701,772	334,851	14,852	[3] 404,972	192,827	8,217
Canada	18,495	8,547	595	11	5	(4)
Congo (Brazzaville)[5]	--	--	--	33,521	16,760	64
Gabon[6]	597,102	305,589	13,409	473,142	236,821	10,669
Ghana	78,271	37,815	2,040	46,940	22,062	1,237
India	2,900	1,283	43	25,593	12,400	620
Mexico	27,291	12,986	492	70,655	32,731	1,803
Morocco	24,460	12,730	1,205	26,309	13,936	1,277
Singapore	193	106	11	--	--	--
South Africa, Republic of	185,636	87,358	3,705	142,354	65,742	2,715
Turkey	8,064	3,790	220	--	--	--
Zaire	105,766	52,834	2,001	[7] 278,598	141,990	4,894
Total	1,914,264	938,122	42,184	[3] 1,620,252	792,695	34,315

[1] Quantities for general imports and imports for consumption were identical.
[2] Part or all of the ore reported to have come from Angola in 1971 and 1972 is believed to have originated in Gabon.
[3] It appears that up to 225,000 additional tons (gross weight) may have come from Brazil in 1972.
[4] Less than ½ unit.
[5] Actually from Gabon.
[6] In addition, in 1971, some imports reported as Angola may have originated in Gabon. In addition, in 1972 Gabon imports reported as Congo (Brazzaville) were approximately 35,000 tons (gross weight), Gabon imports reported as Zaire were approximately 130,000 tons (gross weight), and some or all of the imports reported as Angola probably originated in Gabon.
[7] In 1972, actual imports originating in Zaire were approximately 150,000 tons (gross weight); see footnote 6.

Table 8.—U.S. imports for consumption of ferromanganese, by country

Country	1971			1972		
	Gross weight (short tons)	Mn content (short tons)	Value (thousands)	Gross weight (short tons)	Mn content (short tons)	Value (thousands)
Belgium-Luxembourg	1,456	1,136	$198	9,911	7,775	$1,172
Brazil	--	--	--	6,079	4,592	667
Canada	570	460	118	597	460	211
France	92,321	71,481	10,944	100,084	78,382	14,067
Germany, West	1,552	1,329	599	707	603	267
India	32,717	24,463	3,769	13,093	9,950	1,516
Italy	652	546	166	3,026	2,442	718
Japan	2,757	2,133	488	29,050	23,179	5,374
Norway	14,523	11,633	2,333	25,624	20,181	3,145
Rhodesia	--	--	--	1,504	1,210	171
South Africa, Republic of	90,078	70,892	12,089	152,441	120,617	20,866
Sweden	5,469	4,640	1,530	6,423	5,326	1,672
United Kingdom	--	--	--	(1)	(1)	(1)
Yugoslavia	683	547	158	--	--	--
Total	242,778	189,260	32,392	348,539	274,717	49,846

[1] Less than ½ unit.

Tariffs.—The Rate 1 duty on manganese ore, applicable to most nations, continued to be suspended throughout the year. If effective, it would have been 0.12 cent per pound of contained manganese, the last of the five annual GATT (General Agreement on Tariffs and Trade) reductions effected by Presidential Proclamation 3822 of December 16, 1967. Ore from the U.S.S.R., the People's Republic of China, and certain other specified Communist countries, continued to be subject to the statutory rate of 1 cent per pound of contained manganese.

WORLD REVIEW

Interest in the prospects for exploitation of deepsea manganese nodules continued to develop rapidly in spite of the uncertainties of the legal problems of ownership, mining rights, etc. Many firms and Governments were active, either directly or indirectly. Particularly active were West German and Japanese interests in association with a variety of firms of U.S. and other nationalities. Deepsea Ventures, Inc., Hughes Tool Co., and Kennecott Copper Co. proceeded on their own and were reported to be well advanced with their plans. In probably all cases, manganese has been abandoned as the prime objective in favor of one or more of the associated nickel, cobalt, or copper, the manganese being relegated to byproduct status to assist in the costs, or in some cases to waste. International Nickel and Société Le Nickel were both active, either on their own or as part of a consortium. The question of the environmental effects of deepsea mining received attention with some inconclusive indications that it could be beneficial. The legal aspects were under study by the United Nations as well as elsewhere.

Table 9.—Manganese ore: World production by country [1]

(Short tons)

Country	% Mn [e]	1970	1971	1972 [p]
North America:				
Mexico [2]	35+	301,938	294,198	325,867
United States	35+	4,737	142	578
South America:				
Argentina	26–40	34,847	15,181	[e] 15,500
Bolivia [2 3]	28+	93	785	103
Brazil	38–50	2,071,020	2,868,000	2,127,000
Chile	41–47	29,457	26,277	17,731
Colombia	NA	511	496	542
Peru	27–33	2,119	8,601	12,152
Europe:				
Bulgaria	30+	36,000	45,000	[e] 45,000
Greece	50	7,264	6,754	[e] 6,600
Hungary	30−	186,028	184,100	[e] 184,000
Italy	30−	55,216	33,735	28,260
Portugal	37–44	6,091	5,218	5,895
Spain	30+	11,770	19,929	14,046
U.S.S.R. [4]	NA	7,541,000	8,067,000	8,598,000
Yugoslavia	30+	16,298	17,762	16,909
Africa:				
Angola	30+	[r] 25,353	25,353	26,676
Botswana	30+	[r] 53,269	39,246	757
Egypt, Arab Republic of	NA	[r] 4,836	4,716	[e] 4,800
Gabon	50–53	[r] 1,602,052	2,057,438	2,134,800
Ghana	48+	[r] 446,840	659,800	549,324
Ivory Coast	32–47	25,419	--	--
Morocco	53	123,873	111,846	105,896
South Africa, Republic of	30+	2,953,609	3,567,666	3,606,205
Sudan	36–44	1,279	[e] 1,300	[e] 1,300
Zaire	42+	382,446	426,594	407,283
Asia:				
Burma	NA	121	123	308
China, People's Republic of [e]	30+	1,100,000	1,100,000	1,100,000
India [5]	NA	1,819,936	2,029,000	1,790,000
Indonesia	56	11,946	13,181	8,309
Iran [6]	42+	[r] 10,031	5,500	[e] 5,500
Japan	28–45	298,099	314,164	287,424
Korea, Republic of (South)	35+	3,749	2,495	2,204

See footnotes at end of table.

Table 9.—Manganese ore: World production by country [1]—Continued

(Short tons)

Country	% Mn [e]	1970	1971	1972 [p]
Asia—Continued				
Pakistan	NA	13	100	140
Philippines	52	5,645	5,658	2,746
Thailand	46–50	26,310	15,412	21,883
Turkey	35+	[r] 15,789	14,222	16,620
Oceania:				
Australia	46	[r] 827,561	1,157,703	1,330,795
Fiji	30–50	27,054	8,440	--
New Hebrides	43–44	16,926	16,537	31,137
Total	--	[r] 20,086,545	23,169,672	22,832,290

[e] Estimate. [p] Preliminary. [r] Revised.

[1] In addition to the countries listed, Cuba and South-West Africa also produce manganese ore but information is inadequate to make reliable estimate of output levels. Low grade ore not included in the table has been reported as follows in short tons: Czechoslovakia (about 17% Mn) 1970—95,000; 1971—53,000; 1972—[e] 44,000; Romania (about 22% Mn) about 140,000 in each year; Republic of South Africa (15–30% Mn, in addition to material listed in table) 1970—412,264; 1971—200,220; 1972—112,058.

[2] Estimated on the basis of reported contained manganese.

[3] Exports.

[4] Grade unreported. Source: The National Economy of the U.S.S.R., Central Statistical Administration, Moscow.

[5] Of total 1972 output, 42.4% graded from 35% to 54% Mn. (Comparable 1970 and 1971 production breakdown not available; export figures give 43% and 33% respectively.)

[6] Iranian calendar year beginning March 21, of year stated; all figures apparently are mine run ore.

Angola.—No manganiferous iron ore was produced in 1972. Reported manganese ore production for 1971 was from the mines of Companhia do Manganês de Angola. Exports have been chiefly to Japan but totaled only 12,400 short tons in 1971 compared with 22,600 tons in 1970.

Argentina.—Decree 8203, published in November 1972, restricts manganese ore imports, establishes guidelines for the sale of manganese ore in Argentina, and fixes the prices to be charged. The purpose is to assure a market for all domestically produced manganese ore, which has had to compete since 1970 with Brazilian ore under LAFTA (Latin American Free Trade Association) accords. Because most Argentine mines are small, operate with little benefit of technology, and generally mine ore of poor quality, the costs are high. The decree gives the Ministry of Industry and Mining a year to prepare final plans for the installation of a concentration plant. Manganese ore produced in 1971 averaged 26.58% manganese. Total exports of rhodochrosite in 1971 were 103 short tons, valued at $172,000. The United States received 15 tons. Imports of manganese ore in 1971 totaled 25,000 tons.

Bolivia.—The small quantity of manganese ore produced (exported) in 1971 averaged 28% manganese.

Botswana.—Shipping reports submitted to the Botswana Geological Survey for 1971 showed that the manganese ore from the Lobatse South mine of Marble Lime & Associated Industries Ltd. averaged approximately 46% manganese dioxide, whereas that from the Kanye mine of Anglo American Corp. of South Africa Ltd. ranged from 45% to 68% manganese dioxide. Production for that year from the Kanye mine was about three times that from Lobatse South. The latter is located on the Transvaal border and is an extension of an operation on the Transvaal side of the border. It apparently operates sporadically on a small scale. The Kanye mine closed early in 1972; high transportation costs from mine to railhead at Lobatse were a factor in the closing. The manganese-producing areas of Botswana are heavily faulted and production has varied widely in grade.

Brazil.—The new pellet plant of Indústria e Comércio de Minérios S.A. (ICOMI) at the Amazon River port of Santana, Amapá Territory, produced its first pellets in May, but actual commercial operation was delayed by the problems normally attendant upon breaking-in a new plant. Design capacity is 235,000 short tons per year of pellets containing approximately 60% manganese. The complementary concentrator being built at the mine at Serra do Navio, designed to handle 200 short tons of ore per hour, underwent its first trial tests in December 1971.

Mine-run manganese ore produced in 1972 at Serra do Navio (ICOMI) totaled

1,968,000 short tons. Washed ore production was 1,514,000 tons averaging approximately 48% manganese plus 91,000 tons of washed fines averaging 35% manganese and sent to the new concentrator. Urucum production was 18,000 tons averaging 46.26% manganese, and the output of the Meridional mine in Minas Gerais was 97,000 tons averaging 37.91% manganese.

Manganese ore exports from Brazil in 1971 totaled 1,980,000 short tons, distributed as follows: United States, 771,000; Norway, 319,000; Canada, 146,000; West Germany, 128,000; Netherlands, 113,000; France, 109,000; Japan, 93,000; United Kingdom, 81,000; Italy, 79,000; Argentina, 45,000; Hungary, 24,000; Spain, 23,000; Yugoslavia, 23,000; Czechoslovakia, 21,000; and Mexico, 5,000.

Chile.—Manganese ore produced in both 1972 and 1971 averaged 41.6% managanese.

France.—Near the end of 1972, Ste. des Aciéries de Paris et d'Outreau, a producer of ferromanganese in which U.S. Steel Corp. has a 27% interest, completed construction of an additional blast furnace. This will result in increased ferromanganese production after completion of supporting facilities in early 1973.

Gabon.—Expansion completed in late 1972 brought annual production capacity to 2.3 million short tons of manganese ore. Shipments in 1972 were 2.0 million short tons. In addition to the metallurgical ore produced in the year, having a manganese content of 50% to 52%, there were 38,000 short tons of battery- and chemical-grade ore produced containing 83% to 85% manganese dioxide.

Ghana.—The Government announced its intention to reorganize all the country's operating mining companies; the Government would obtain 55% equity in each. African Manganese Co., a wholly owned subsidiary of Union Carbide Corp., is the only operating manganese mine in Ghana.

Greece.—Exports of pyrolusite concentrates in 1971, apparently battery-grade, totaled 5,200 short tons, of which 2,900 tons went to West Germany and 1,500 tons went to France, leaving the small remainder for other countries. Concentrates produced had a manganese content of 49% to 50%.

India.—Ferromanganese continued to be produced in the same seven plants. Production in 1972 was 179,000 short tons with installed annual capacity of 215,000 tons. Domestic consumption was approximately 89,000 tons, and exports totaled 62,000 tons. Distribution of the exports was similar to that of 1971, with the United States taking 33,000 tons; Sweden, 16,000 tons; Romania, 6,800 tons; Egypt, 5,200 tons; New Zealand, 900 tons; and Iran, 20 tons. Japan's omission in 1972 was the only significant change.

Of the 1,790,000 short tons of manganese ore reported as production for 1972, 1,032,000 tons or 57.6% was ferruginous manganese ore containing less than 35% manganese, 724,000 tons or 40.5% was classified as Second Grade manganese ore containing 35% to 48% manganese, 30,000 tons or 1.7% was First Grade manganese ore containing more than 48% manganese, and 3,600 tons or 0.2% was peroxide manganese ore having a maximum manganese dioxide content of 86%. Exports totaled 895,000 tons divided as follows: Ferruginous, 596,000 tons (Japan, 580,000; Czechoslovakia, 16,000); First Grade, 26,000 tons (United States, 17,000; Belgium, 9,000); Second Grade, 270,000 tons (Japan, 131,000; Czechoslovakia, 51,000; Bulgaria, 32,000; Belgium, 26,000; France, 15,000; Taiwan, 8,200; South Korea, 6,600); Peroxide, 2,525 tons (Japan, 2,500; United Kingdom, 25). Domestic consumption of manganese ore totaled 870,000 tons, of which 424,000 tons was for ferromanganese production, 435,000 tons for iron and steel, and 10,000 tons for dry cell manufacture, leaving 1,000 tons for other uses. Imports of manganese ore and concentrate totaled 5,800 tons, all of which was battery grade. Ghana supplied 4,100 tons; the United Kingdom, 1,500 tons; the Netherlands, 180 tons; and Greece, 5 tons.

Of a total of 370 registered manganese mines, 20 are in the public sector. From 310 to 315 of the registered mines may be expected to be active in an average year. Many of the private sector mines are small open pit operations producing less than 1,000 tons per year. Only Manganese Ore (India) Limited, a public sector company, can negotiate its own export contracts. Others must sell directly to the Government sales agency, Minerals and Metals Trading Corp. (MMTC), for rupees. The corporation then exports the ore under terms of trade agreements.

Indonesia.—For the last several years, all manganese ore produced has been of chemical grade, marketed in Japan and the Netherlands. Ore produced in 1972 had a reported manganese dioxide content of 90%. Production is by the Regional Government Enterprise in West Java.

Italy.—Reported average grade of manganese ore produced in 1972 was 25% manganese, the same as that for 1971. The sharp drop in production of manganese ore in 1971 was largely the result of reduced output of the Gambatesa (Genova) mine of Soc. Italsider at Varese Ligure in Genoa Province. Italy apparently has only one other manganese mine, the Cano Becco mine of Soc. Guiseppe Ucchedda at Carloforte in Cagliari Province. Its average annual production in the 1964–66 period was 100 tons of pyrolusite ore, averaging 30% manganese in 1966. Italy imported 320,000 short tons of manganese ore in 1971. The Republic of South Africa supplied 136,000 tons; Brazil, 78,000 tons; India, 38,000 tons; and Gabon, 20,000 tons.

Japan.—Capacity to produce electrolytic manganese metal was reported to be 17,200 short tons per year; Tekkosha Co. accounted for 13,200 tons, and Chuo Denko (Central Electric) accounted for 4,000 tons. Domestic demand was forecast at approximately 6,000 to 7,000 tons per year.[2] Tekkosha was planning a new plant to produce 500 to 1,000 tons per year. Because at least half of the output would be for export, serious consideration was being given to a foreign site.[3]

Hanshin Yosetsu Co. suspended production of synthetic manganese dioxide at the end of July, thereby dropping Japan's annual supply capacity to 43,600 short tons from 48,300 tons. Demand for domestic consumption and export was expected to be 44,000 to 45,000 tons in 1973. In anticipation of a supply shortage after 1974, Mitsui Mining and Smelting Co., Tekkosha Co., and other producers planned to start installing additional equipment and otherwise expand their plants in the first half of 1973.[4] Domestic demand in 1971 was 14,000 tons.[5]

Japan's production of dioxide ore or concentrate in 1972 was 850 short tons averaging 72.1% manganese dioxide; in 1971, it was 1,300 tons averaging 62.6% manganese dioxide. The grade of the metallurgical concentrate produced averaged 27.9% manganese in both years. Production of ferromanganese was 610,000 short tons in 1972 and 588,000 tons in 1971; silicomanganese, 378,000 tons in 1972 and 358,000 tons in 1971; electrolytic manganese metal, 8,456 tons in 1972 and 10,875 in 1971; and synthetic manganese dioxide, 43,440 in 1972 and 46,510 in 1971.

Malaysia.—There was 31,000 short tons of ferruginous manganese ore produced in 1972, compared with 29,000 tons in 1971.

Morocco.—All manganese ore produced in 1972 was chemical-grade concentrate averaging 84% manganese dioxide.

New Hebrides.—Manganese ore exports, reported as production in 1971, were all concentrates averaging 44.4% manganese.

Peru.—Production of manganese ore in 1972 averaged 27.8% manganese, compared with 29.9% in 1971.

Portugal.—The manganese ore produced in 1972 averaged 37% manganese; in 1971, it averaged 38%. In addition, approximately 50,000 short tons of manganiferous iron ore was produced each year; analyzing 42.4% iron and 7.8% manganese in 1972, and 42.6% iron and 7.7% manganese in 1971.

South Africa, Republic of.—Production of the various grades of metallurgical ore in 1972 was as follows, in short tons: 30 to 40% manganese, 2,362,000; 40% to 45%, 192,000; 45% to 48%, 128,000; and over 48%, 820,000. Local sales were, respectively, 452,000, 152,000, 56,000, and 187,000 tons. Of the chemical ore produced 95,000 tons contained 35% to 65% manganese dioxide, and 8,800 tons contained 65% to 75% manganese dioxide. Local sales were 90,000 and 5,800 tons, respectively. Production of ferruginous manganese ore, containing 15% to 30% manganese and 20% to 35% iron, totaled 112,000 tons. Exports were 215,000 tons and there were no local sales. Total exports of metallurgical ore were 2,486,000 tons.

By increasing cell and ancillary capacity, Electrolytic Metal Corp. (Pty) Ltd. (EMCOR), subsidiary of General Mining and Finance Corp. Ltd., planned a further increase in production of electrolytic manganese metal to 19,300 short tons, to be achieved as early as July 1973. All of EMCOR's production is marketed by A. John-

2 Metal Bulletin (London). No. 5723, Aug. 8, 1972, p. 12.
3 Metal Bulletin (London). No. 5738, Oct. 3, 1972, p. 15.
4 Japan Metal Bulletin (Tokyo). Sept. 9, 1972, p. 5.
5 Metal Bulletin (London). No. 5698, May 9, 1972, p. 18.

son and Co., Stockholm, Sweden, one of EMCOR's shareholders. Delta Metal Co. Ltd., a United Kingdom producer of copper alloy mill products, formed Delta Manganese (Pty) Ltd. to build and operate an electrolytic manganese metal plant at Nelspruit, eastern Transvaal. Production was scheduled to begin by the end of 1973 with an initial rated annual capacity of 17,600 short tons. The ultimate capacity of close to 31,000 tons was expected to be reached within about 4 years after the commencement of operations. Metallurgical ore is to be the raw material, and virtually all of the product will be exported.

Spain.—The manganese ore produced in 1972 had an average manganese content of 31.0%.

Surinam.—Several manganese deposits of possible economic interest were discovered in the period from 1955 to 1966. Of these the Lada Soela deposits on the Upper Tapanahony River are probably the most important. The laterite cap and surrounding float in the most promising part of these deposits was estimated to constitute a reserve of approximately 550,000 short tons averaging 40% manganese and 8% iron. This float is associated with 1.4 million tons of nodular laterite containing 15% manganese and 20% iron. Float and nodular laterite at Maripa Hill, Suriname River, was estimated at more than 1 million tons averaging 25% to 30% manganese. Reserves of Apoema Soela, Marowijne River, were estimated at 300,000 to 500,000 tons of ore averaging 30% manganese, and those of Plet Ridge, Upper Saramacca River, 100,000 to 150,000 tons containing about 35% manganese. Gondites (manganese quartzites) and lateritic manganese occurrences are widespread.[6]

Thailand.—Battery-grade ore (75% manganese dioxide) production in 1972 was 6,000 short tons; chemical-grade ore (minimum 75% manganese dioxide) production amounted to 26 tons. Exports of battery-grade were 1,100 tons in 1972 and 150 tons in 1971. Metallurgical ore exported in 1972 was 2,500 tons, compared with 9,000 tons in 1971.

United Kingdom.—All of the United Kingdom output of ferromanganese is by the Cleveland No. 5 blast furnace at the South Teesside Works of British Steel Corp. and the Cleveland No. 4 furnace. The total amounts to 4,000 to 5,000 tons per week.[7]

Zaire.—Société Minière de Kisenge (SMK) continued to mine ore containing 40% to 42% manganese from two open pits at Kisenge near the Angola border. Crushing, blending, and washing upgraded the ore to a shipping product containing 50% manganese for railing to the Angolan port of Lobito. Production in 1972 consisted of 313,000 short tons of ore containing 50% manganese, and 87,000 tons of fines that develop in the process and contain 46% to 48% manganese. These are also exported. Exports in 1972 included 7,700 tons of battery or chemical grade containing 80% manganese dioxide.

TECHNOLOGY

In an evaluation of the sulfatization-reduction process, a variation of the high-temperature differential sulfatization process developed at its Twin Cities Metallurgy Research Center for the recovery of manganese from low-grade Cuyuna Range (Minnesota) manganiferous iron ore, the Bureau of Mines estimated an operating cost of $211 per short ton of contained manganese to produce pellets containing approximately 90% Mn_3O_4. This was based upon a manganiferous iron ore feed containing 4.8% manganese and 33.4% iron for a plant with a productive capacity of 100 tons of contained manganese per day. The operating cost for a plant capable of producing 1,000 tons of contained manganese per day was estimated to be $158. These costs have the benefit of a credit for byproduct iron ore pellets. In the case of the 100-ton plant, this amounts to $120.50. In the process the ore is reacted with sulfur dioxide in shaft furnaces at temperatures between 1,100° and 1,560° F. In this temperature range the manganese is sulfatized but the iron is not. The resulting mixture of manganese sulfate and iron oxide is cooled and fed to a reduction furnace where the iron oxide is reduced to

[6] Geological and Mining Service, Ministry of Development. 30 Years, Geological and Mining Service of Suriname, 1973. Paramaribo, Surinam, December 1972, p. 21.

[7] Iron and Steel (London). V. 45, No. 5, October 1972, p. 469.

magnetite by the use of a reformed natural gas. The manganese is then leached out with water, and manganese sulfate crystals are recovered from the solution by evaporation. After pelletizing, these crystals are calcined to the final Mn_3O_4 product. Magnetic separation recovers the magnetite from the leach residue. This is pelletized and calcined to obtain the iron byproduct.[8]

A single-stage cocurrent leaching and thickening system[9] for extracting manganese from umber using simulated steel-mill sulfuric acid "pickle liquors" was found to be versatile and technically feasible, and to be simpler to operate and control than a three-stage countercurrent system reported earlier.[10] The work was at small pilot plant scale using umber from Cartersville, Ga., which analyzed 4.4% manganese and 42.0% iron. The use of a centrifuge in place of thickeners offered an advantage with respect to space, and compared favorably otherwise except that costs would be higher.

The geologic environments, and modes of origin, of three fairly common manganese oxide minerals—manganite, hausmannite, and braunite—were studied after positive identification by X-ray and spectrographic analysis of pure specimens. Before development of these analytical methods, identity was dependent on the procurement of good crystals or good chemical analysis of unadulterated specimens. As a result, many old reports of occurrences are suspect. From the present study, it was concluded that manganite is not as widespread as had been supposed, and that it is for the most part of hypogene origin; that is, deposited by warm or hot waters rising from depth. In many places, however, small quantities of manganite have been formed by surficial alteration of minerals such as rhodochrosite, rhodonite, or the sulfide, alabandite. Hausmannite was concluded to be most often, if not always, of hypogene origin, formed either in epigenetic veins or by hydrothermal alteration of manganese carbonate or oxide minerals. Braunite was, like manganite, either of hypogene origin deposited from solutions rising from depth or of supergene origin from descending surface waters. It was noted to be the dominant oxide in deposits that had undergone intense metamorphism, as in the case of certain Indian deposits.[11]

With the objective of utilizing New Brunswick's manganiferous shale, occurring near Woodstock and containing approximately 10% manganese, and the province's refractory base metal sulfide ores containing much massive pyrite, a process has been developed by W. J. Wark, Woodstock, N.B., that would result in recovery of manganese, copper, and lead metals, and a chemical-grade zinc sulfide. The shale is ground to 200 mesh and blended with the sulfide tailings, or comparably ground sulfide ore, in proper proportion for heating at low temperature to achieve an exchange of sulfur between the pyrite and the manganese. Manganese, copper, lead, and zinc sulfates are formed, with iron discarded as insoluble ferric oxide. Manganese metal produced electrolytically, besides being one of the final products, is used to reduce the copper and lead, and elemental sulfur is discharged.[12]

Researchers at the Bell Laboratories, Murray Hill, N.J., found that crushed single crystals of rare-earth oxides of manganese, and also those of cobalt, compared favorably with commercial platinum catalysts in oxidizing carbon monoxide for its control in automobile exhausts.[13] The work suggested that these lead-bearing manganites might have certain advantages, including that of cost and the fact that they are not poisoned by lead. However, more work is deemed necessary before commercial possibilities can be evaluated.[14] At about the same time, Japan's Mitsui Mining and Smelting Co. was

---

8 Henn, J. J., R. A. Clifton, and F. A. Peters. Evaluation of the Sulfatization-Reduction Process for Recovering Manganese and Iron Oxide Pellets. BuMines RI 7652, 1972, 27 pp.

9 LeVan, H. P. Extraction of Manganese From Georgia Umber Ores by a Sulfuric Acid-Ferrous Sulfate Process (In Two Parts). 2. Cocurrent Extraction and Centrifuge Tests. BuMines RI 7695, 1972, 19 pp.

10 LeVan, H. P., E. G. Davis, and F. E. Brantley. Extraction of Manganese From Georgia Umber Ore by a Sulfuric Acid-Ferrous Sulfate Process (In Two Parts). 1. Countercurrent-Decantation Extraction and Agglomeration of Leached Residue Tests. BuMines RI 6692, 1965, 21 pp.

11 Hewett, D. F. Manganite, Hausmannite, Braunite: Features, Modes of Origin. Econ. Geol., v. 67, No. 1, January–February 1972, pp. 83–102.

12 Northern Miner (Toronto). V. 58, No. 5, Apr. 20, 1972, p. 10.

13 Voorhoeve, R. J. H., J. P. Remeika, P. E. Freeland, and B. T. Matthias. Rare-Earth Oxides of Manganese and Cobalt Rival Platinum for the Treatment of Carbon Monoxide in Auto Exhaust. Sci., v. 177, No. 4046, July 28, 1972, pp. 353–354.

14 Ruth, John P. Wider Probe of Low-Cost Oxides as Catalysts in Exhaust Control. Am. Metal Market, v. 79, No. 142, Aug. 1, 1972, p. 1.

reported to be almost ready to market its newly developed manganese catalytic afterburner in Japan at a rate of 5,000 units per month, and at a lower price than that for the platinum converter. It was reported that it would reduce nitrogen oxide and hydrocarbon emissions to some extent, as well as those of carbon monoxide.[15]

A discussion of the present status of undersea mining and exploration reported the continuing interest in the metalliferous muds of the Red Sea and the manganese nodules of the deep ocean floors. Process development work at the University of California at Berkeley has indicated that nickel, copper, and cobalt might be differentially leached from sea-floor manganese nodules at favorable costs. After crushing to approximately minus 20 mesh, most of the copper is leached with sulfuric acid at pH 2 and a temperature of approximately 25° C, followed by leaching most of the nickel from the remaining material at the same pH and a temperature of 50° C. It was reported that very little manganese or iron are dissolved.[16]

---

15 Am. Metal Market. V. 79, No. 148, Aug. 14, 1972, p. 13. Metals Week. V. 43, No. 35, Aug. 28, 1972, p. 1.

16 Mero, J. L. Recent Concepts in Undersea Mining. Min. Cong. J., v. 58, No. 5, May 1972, pp. 43–48, 54.

Mercury

By V. Anthony Cammarota, Jr. [1]

Primary mercury production of 7,286 flasks [2] in 1972, valued at $1.6 million, was the lowest since 1951. Only 21 mines were active during the year, compared with 56 mines in 1971, when 17,883 flasks were produced. By yearend a few mines remained, most of which were intermittent producers.

Secondary production of 12,651 flasks was down from the 1971 level. Some of the mercury came from a closed mercury-cell chlor-alkali plant and releases by the General Services Administration (GSA).

The consumption of 52,907 flasks in 1972 was slightly higher than in 1971. Increases were registered for agriculture, dental preparations, and industrial and control instruments, but the use in electrical apparatus declined.

Consumers worked off inventory as prices continued their decline to a low of $145 per flask in April. At the same time producers stockpiled metal. As prices recovered in the second half to finish the year at $285 per flask, producers took advantage of the rally to sell metal and consumers increased stocks.

Exports were down sharply. Imports were up slightly from 1971, with Algeria becoming a significant supplier. World production of mercury in 1972 decreased 6% from that of 1971. Spain increased production, whereas Canada, Italy, Mexico, and Yugoslavia showed declines.

The West German Government and a team of British and Australian divers both claimed ownership of an undisclosed quantity of mercury recovered from a U-boat sunk off the Malaysian coast during World War II. German U-boats are believed to have used mercury as ballast.

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 1972.

In July, GSA resumed its sale of surplus mercury on a sealed bid basis at the rate of 500 flasks per month. In August 450 flasks were sold at an average price of $225.77 per flask, but in September 49 flasks were sold for an average of $269.44 per flask. Total releases for the year of 512 flasks included 13 flasks transferred to the National Aeronautics and Space Administration.

As of December 31, 1972, total strategic stockpile accumulations from all programs stood at 200,105 flasks.

In March, the Environmental Protection Agency (EPA), under terms of the Federal Insecticide, Fungicide and Rodenticide Act, canceled all biocidal uses of mercury, and in addition suspended the registrations for alkyl compounds and nonalkyl uses on rice seed, in laundry products, and in marine antifouling paint.[3] The suspension order immediately halted all interstate shipment of the products. Under a cancellation order, sale and interstate commerce are permitted while an appeal is filed by manufacturers and a final decision is reached by a special scientific panel.

Pursuant to the Federal Food, Drug, and Cosmetic Act, the Food and Drug Administration proposed removing mercury from cosmetics other than those used around the eye.[4]

The goal of the Federal Water Pollution Control Act of 1972, as amended, is to

---

[1] Physical scientist, Division of Nonferrous Metals.

[2] Flask as used throughout this chapter refers to the 76-pound flask.

[3] Federal Register. Certain Products Containing Mercury, Cancellation of Registration. V. 37, No. 61, Mar. 29, 1972, pp. 6419–6420.

[4] Federal Register. Use of Mercury in Cosmetics Including Use as Skin-Bleaching Agent in Cosmetic Preparations Also Regarded as Drugs. V. 37, No. 127, June 30, 1972, pp. 12967–12968.

Table 1.—Salient mercury statistics

	1968	1969	1970	1971	1972
United States:					
Producing mines	87	109	79	56	21
Production ---- flasks	28,874	29,640	27,296	17,883	7,286
Value ---- thousands	$15,464	$14,969	$11,130	$5,229	$1,590
Exports ---- flasks	7,496	507	4,653	7,232	400
Reexports ---- do	103	108	50	--	563
Imports:					
For consumption ---- do	23,246	31,924	21,972	28,449	28,834
General ---- do	23,956	30,848	21,672	29,750	29,179
Stocks Dec. 31 ---- do	22,907	22,692	16,554	16,862	15,708
Consumption ---- do	75,422	77,372	61,503	52,257	52,907
Price: New York, average per flask	$535.56	$505.04	$407.77	$292.41	$218.28
World:					
Production ---- flasks	259,694	289,267	284,014	298,552	279,508
Price: London, average per flask	$546.80	$536.41	$411.45	$282.46	$203.01

Table 2.—Mercury statistics, 1925–72

(Flasks)

Year	Production			U.S. Government releases	Imports for consumption	Exports, including reexports	Consumption [3]	Average price per flask, New York
	United States		World [2]					
	Primary	Secondary [1]						
1925	9,053	--	103,344	--	20,580	201	29,432	$84.24
1926	7,541	--	115,969	--	25,634	114	33,061	93.13
1927	11,128	--	149,905	--	19,941	(4)	30,900	118.16
1928	17,870	--	149,083	--	14,562	(4)	32,300	123.51
1929	23,682	--	162,699	--	14,917	(4)	38,500	122.15
1930	21,553	--	108,985	--	3,725	(4)	25,200	115.01
1931	24,947	--	99,069	--	549	4,984	20,512	87.35
1932	12,622	--	82,644	--	3,886	214	16,294	57.93
1933	9,669	--	59,828	--	20,315	(4)	29,700	59.23
1934	15,445	--	76,939	--	10,192	(4)	25,400	73.87
1935	17,518	--	100,261	--	7,815	(4)	25,200	71.99
1936	16,569	--	123,878	--	18,088	263	34,400	79.92
1937	16,508	--	133,136	--	18,917	454	35,000	90.18
1938	17,991	--	149,953	--	2,362	713	19,600	75.47
1939	18,633	--	140,050	--	3,499	1,208	20,900	103.94
1940	37,777	--	206,831	--	171	9,617	26,800	176.87
1941	44,921	--	265,994	--	7,740	2,590	44,800	185.02
1942	50,846	--	260,892	--	38,941	7,806	49,700	196.35
1943	51,929	--	228,288	--	47,805	15,237	54,500	195.21
1944	37,688	--	154,733	NA	19,553	876	42,900	118.36
1945	30,763	--	121,180	NA	68,617	2,731	62,429	134.89
1946	25,348	4,000	143,846	--	13,894	3,264	31,552	98.24
1947	23,244	3,500	155,562	--	13,008	3,979	35,581	83.74
1948	14,388	2,170	94,682	--	31,951	1,447	46,253	76.49
1949	9,930	1,385	120,786	--	103,141	1,405	39,857	79.46
1950	4,535	2,000	143,253	--	56,080	1,333	49,215	81.26
1951	7,293	2,000	146,667	--	47,860	916	56,848	210.13
1952	12,547	2,500	150,499	--	71,855	659	42,556	199.10
1953	14,337	2,800	159,719	--	83,393	1,462	52,259	193.03
1954	18,543	6,100	179,297	--	64,957	2,326	42,796	264.39
1955	18,955	10,030	185,116	--	20,354	718	57,185	290.35
1956	24,177	5,850	221,022	--	47,316	3,105	54,143	259.92
1957	34,625	5,800	239,525	--	42,005	5,194	52,889	246.98
1958	38,067	5,400	246,160	--	30,196	1,254	52,617	229.06
1959	31,256	4,950	223,527	--	30,141	1,193	54,895	227.48
1960	33,223	5,350	241,801	--	19,488	674	51,167	210.76
1961	31,662	8,360	239,610	--	12,326	465	55,763	197.61
1962	26,277	5,800	244,592	--	31,552	481	65,301	191.21
1963	19,117	6,520	239,652	4,000	42,872	227	77,963	189.45
1964	14,142	7,519	255,133	17,000	41,153	384	81,354	314.79
1965	19,582	14,906	267,873	31,764	16,238	8,037	73,560	570.75
1966	22,008	8,535	264,994	7,865	31,364	833	71,509	441.72
1967	23,784	10,696	232,073	11,454	24,348	3,102	69,517	489.36
1968	28,874	10,570	259,694	23,810	23,246	7,599	75,422	535.56
1969	29,640	10,573	289,267	3,077	31,924	615	77,372	505.04
1970	27,296	7,348	284,014	703	21,972	4,703	61,503	407.77
1971	17,883	10,899	298,552	5,767	28,449	7,232	52,257	292.41
1972	7,286	12,139	279,508	512	28,834	963	52,907	218.28

NA Not available.
[1] Excludes Government releases.
[2] Primary mercury only, including United States.
[3] Apparent consumption 1925–26, 1931, 1932, 1936–39; estimated by Bureau of Mines 1927–30; 1933–35; actual consumption 1940–72.
[4] Not separately classified.

eliminate all pollutant discharges by 1985. Title 3, Section 301, states that by July 1977 effluent limitations will be developed requiring best practicable control currently available, and by July 1983 best available technology economically achievable will be required. Chlor-alkali plants using the mercury cell would be affected by this law.

DOMESTIC PRODUCTION

The largest producer, New Idria Mining and Chemical Co., closed its New Idria mine in San Benito County, Calif., in May, but retained the mine on a standby basis for the balance of the year. Other large producing mines that closed during the year included the Corona, Gibraltar, and Mt. Jackson in California, and the Idaho-Almaden in Idaho. A total of 21 mines reported production, down from 56 in 1971. By yearend less than six remained active. In the first quarter production was about 3,200 flasks, but as mines closed or curtailed production, it fell to about 600 flasks in the fourth quarter.

Low prices and slackened demand were cited as reasons for the closures. Some exploration and development work was conducted by several small operators. The number of mines reporting outputs of 1,000 flasks or more decreased from six in 1971 to one in 1972. Properties producing 500 to 999 flasks decreased from six to four, and properties producing 100 to 499 flasks decreased from nine to seven. Of the total production of 7,286 flasks, 69% came from producers of 500 flasks or more and 26% from producers of 100 to 499 flasks. The remaining 5% came from other producers. Principal mines in 1972 were as follows:

State	County	Mine
PROPERTIES PRODUCING 1,000 FLASKS OR MORE		
California	Napa	Knoxville.
PROPERTIES PRODUCING 500 TO 999 FLASKS		
California	San Luis Obispo	Buena Vista.
Do	Sonoma	Culver-Baer.
Do	San Benito	New Idria.
Nevada	Pershing	Red Bird.
PROPERTIES PRODUCING 100 TO 499 FLASKS		
Alaska	Kuskokwim River Region	White Mountain.
California	Marin	Chileno Valley.
Do	Santa Clara	Guadalupe.
Do	Napa	Manhattan-One Shot.
Do	Sonoma	Mt. Jackson.
Do	Santa Clara	New Almaden.
Idaho	Washington	Idaho-Almaden.

Although there were 25 fewer mines in California in 1972 than in 1971, the State increased its share of total mercury production from 75% to 79%. A significant amount of mercury metal was produced at the Buena Vista mine from ore that was stockpiled during the past several years. The Knoxville mine, which had been closed for several years, produced a substantial quantity of metal from stockpiled ore and ore mined in 1972. The Santa Clara Quicksilver Co., which operated the New Almaden mine under lease from New Idria Mining, treated ore from underground workings and old mine dumps.

Nevada, with only three mines operating compared with eight in 1971, produced 11% of the total mercury. Near Lovelock, Pershing County, the Golden Cycle Technology Corp. produced cinnabar concentrate from the Pershing mine for export to the Republic of Korea and Taiwan, and also recovered a small amount of metallic mercury. The Carlin Gold Mining Co., which recovered mercury as a byproduct from its gold mine in Eureka County, was the only continuous producer of mercury in Nevada.

The Idaho-Almaden mine in Idaho, which accounted for 2% of the total U.S. production, closed in February. The White Mountain mine in Alaska shipped most of its cinnabar concentrate to Oregon for retorting, but exported a small quantity to

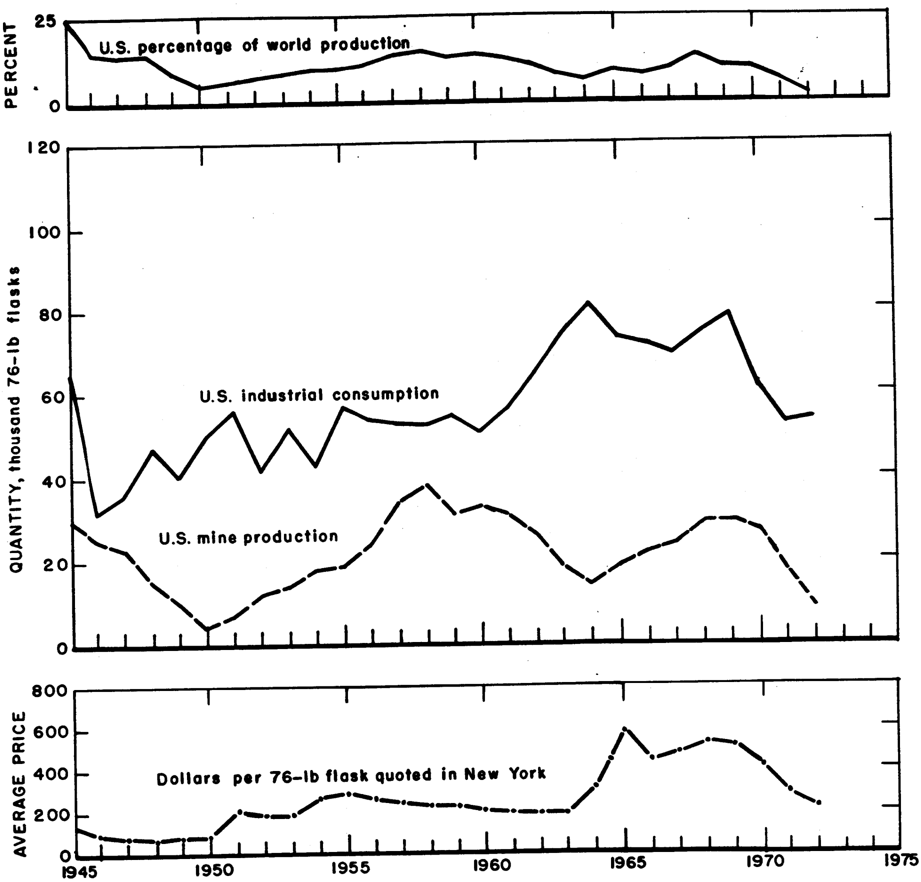

Figure 1.—Trends in production, consumption, and price of mercury.

Table 3.—Mercury produced in the United States, by State

Year and State	Producing mines [1]	Flasks	Value [2] (thousands)
1971			
California	r 39	r 13,489	r $3,944
Idaho	1	1,057	309
Nevada	8	1,589	465
Alaska, Arkansas, New York, Oregon, Texas	8	1,748	511
Total	r 56	r 17,883	r 5,229
1972			
California	14	5,788	1,263
Idaho	1	161	35
Nevada	3	810	177
Alaska, New York, Texas	3	527	115
Total	21	7,286	1,590

r Revised.
[1] Mercury mines only.
[2] Value calculated at average New York price.

the Orient. Two mines in Texas, the Fresno and Whit-Roy, were active for several months.

The St. Joe Minerals Corp. continued to recover byproduct mercury from its zinc smelter at Monaca, Pa. The zinc concentrate originated from the company's zinc mine in New York.

The average grade of all ore processed in 1972, including ore treated in concentrators, increased to 6.5 pounds of mercury per ton, the highest since 1964. About one-quarter of the ore treated contained over 20 pounds of mercury per ton.

The much-reduced level of GSA releases lowered secondary production of mercury to 12,651 flasks from 16,666 flasks in 1971 Dental amalgams, scrap batteries, various types of sludges, two dismantled mercury-cell chlor-alkali plants, and discarded mercury-containing instruments were the major sources of secondary mercury.

Table 4.—Mercury ore treated and mercury produced in the United States [1]

Year	Ore treated (short tons)	Mercury produced	
		Flasks	Pounds per ton of ore
1968	434,193	28,857	5.1
1969	432,591	28,552	5.0
1970	424,510	26,795	4.8
1971	r 265,790	r 17,444	5.0
1972	81,543	6,957	6.5

r Revised.
[1] Excludes mercury produced from old surface ores, dumps, placers, and as a byproduct.

Table 5.—Production of secondary mercury in the United States

Year	Flasks [1]
1968	34,380
1969	13,650
1970	8,051
1971	16,666
1972	12,651

[1] Includes GSA releases.

CONSUMPTION AND USES

Consumption at 52,907 flasks was 1% higher than in 1971. Increased consumption was noted for agriculture, dental preparations, and industrial and control instruments. Electrical apparatus, down 8%, showed the largest decline of the major uses, mainly because of a fall in consumption for batteries. Mercury usage for the electrolytic preparation of chlorine and caustic soda fell for the third consecutive year. Secondary mercury was transferred from a dismantled chlor-alkali facility to other plants within the Olin Corp. to increase the capacity of existing cells. The major uses of mercury were electrical apparatus, 29%; electrolytic preparation of chlorine and caustic soda, 22%; antifouling and mildew-proofing for paint, 16%; and industrial and control instruments, 12%.

Although total chlorine production increased by 6% to 9.9 million short tons, only 24.2% of the total was produced in mercury cells. In 1971, 27.2% of the chlorine was produced in mercury cells, with

Table 6.—Mercury consumed in the United States, by use

(Flasks)

Use	1968 [1]	1969	1970	1971	1972
Agriculture	3,430	2,689	1,811	1,477	1,836
Amalgamation	267	195	219	--	--
Catalysts	1,914	2,958	2,238	r 1,012	800
Dental preparations	3,079	2,880	2,286	r 2,361	2,983
Electrical apparatus	19,630	18,490	15,952	r 16,885	15,553
Electrolytic preparation of chlorine and caustic soda	17,453	20,720	15,011	r 12,154	11,519
General laboratory use	1,989	1,936	1,806	r 1,798	594
Industrial and control instruments	7,978	6,655	4,832	4,871	6,541
Paint:					
Antifouling	392	244	198	414	32
Mildew-proofing	10,174	9,486	10,149	8,191	8,190
Paper and pulp manufacture	417	558	226	2	1
Pharmaceuticals	424	712	690	682	578
Other [2]	8,275	9,134	5,858	r 2,407	4,258
Total known uses	75,422	76,657	61,276	r 52,254	52,885
Total unknown uses	--	715	227	3	22
Grand total	75,422	77,372	61,503	r 52,257	52,907

r Revised.
[1] Uses include proportion of mercury previously reported under "Redistilled."
[2] Includes mercury used for installation and expansion of chlorine and caustic soda plants.

Table 7.—Mercury consumed in the United States in 1972

(Flasks)

	Primary	Redistilled	Secondary	Total
Agriculture [1]	1,809	18	9	1,836
Catalysts	693	--	107	800
Dental preparations	56	2,621	306	2,983
Electrical apparatus	10,317	4,502	734	15,553
Electrolytic preparation of chlorine and caustic soda	9,537	--	1,982	11,519
General laboratory use	346	238	10	594
Industrial and control instruments	2,016	3,530	995	6,541
Paint:				
Antifouling	32	--	--	32
Mildew-proofing	8,183	4	3	8,190
Paper and pulp manufacture	1	--	--	1
Pharmaceuticals	272	306	--	578
Other	1,955	516	1,787	4,258
Total known uses	35,217	11,735	5,933	52,885
Total unknown uses	--	7	15	22
Grand total	35,217	11,742	5,948	52,907

[1] Includes fungicides and bactericides for industrial purposes.

Table 8.—Stocks of mercury, December 31

(Flasks)

Year	Producer	Consumer and dealer	Total
1968	1,059	21,848	22,907
1969	2,920	19,772	22,692
1970	3,861	12,693	16,554
1971	r 5,373	r 11,489	r 16,862
1972	4,171	11,537	15,708

r Revised.

the high of 28.6% being achieved in 1968. Consumption of mercury per ton of chlorine produced, 0.37 pound, remained at the 1971 level. Planned expansions are expected to increase chlorine capacity about 15% to 20% by the end of 1974, but none of the new capacity will use mercury cells. Sobin Chlor Alkali Inc. installed the borohydride process for recovering mercury from water effluent and a molecular sieve system for mercury vapor recovery from the hydrogen gas stream. The recovered mercury is being reused at the plant. Olin Corp. closed its Saltville, Va., mercury-cell facility and will use the mercury to fill the demand at its other plants.

Manufacturers of mercury compounds used in paint filed an appeal of EPA's order canceling the registration of these materials for use in mildew-proofing paint. Consumption of mercury in mildew-proofing paint remained generally unchanged from 1971. Apparently some substitution of mercury compounds by organics took place during the year, as indicated by the fact that the total volume of paint shipments was up 6% over last year according to the Bureau of the Census.

PRICES

The price of mercury continued its decline into 1972, reaching $145 per flask in late April, the lowest level in 22 years. Sluggish demand and the intention of EPA to ban the use of mercury in paint were the major reasons for the decline. From May through September the price recovered dramatically to the $265 to $275 range. The market was buoyed by the news of a significant cutback in Canadian production, a bone-dry supply, and the conservative selling policy of GSA for its surplus mercury in July and August. In addition, there were reports that an effort was underway by the major world producers to hold back offerings to improve prices. Prices dropped somewhat in the fall but recovered to finish the year at $280 to $285. The average price of mercury at New York was $218.28 per flask in 1972.

Prices on the London market were below New York prices by about $5 to $23 per flask. In midyear optimism generated by purchase tenders from India, Poland, and Colombia lifted prices. The European market was weak from a heavy influx late in the year of the U.S.S.R. mercury which fetched lower prices. Also, some traders believed the low prices were the result of manipulative moves on the part of trading interests with buying contracts.

Table 9.—Average monthly prices of mercury at New York and London

(Per flask)

Month	1971 New York [1]	1971 London [2]	1972 New York [1]	1972 London [2]
January	$349.50	$359.76	$213.24	$208.13
February	346.26	359.61	207.75	198.84
March	328.26	335.80	185.00	173.39
April	309.95	316.57	152.50	141.36
May	281.50	285.89	171.74	153.25
June	266.23	251.09	196.36	177.39
July	297.95	278.68	211.15	191.12
August	283.86	255.36	245.78	222.50
September	283.10	255.97	255.65	241.11
October	271.35	244.22	254.96	237.78
November	258.75	233.90	256.96	242.75
December	230.24	210.18	269.65	248.50
Average	292.41	282.46	218.28	203.01

[1] Metals Week, New York.
[2] Metal Bulletin prices. In 1971, reported in terms of pounds sterling converted to U.S. dollars by using average rates of exchange recorded by Federal Reserve Board. In 1972, reported in terms of U.S. dollars.

FOREIGN TRADE

Mercury exports decreased significantly to 400 flasks from 7,232 flasks in 1971. The major recipient was East Germany with 250 flasks, followed by Canada, 57 flasks, Colombia, 18 flasks, and Venezuela, 17 flasks. Of the 563 flasks reexported, East Germany received 550 flasks and Sweden 13 flasks.

Imports for consumption, which include mercury imported for immediate consumption plus material withdrawn from bonded warehouses, increased by 1% to 28,834 flasks. General imports, which include mercury imported for immediate consumption

Table 10.—U.S. exports and reexports of mercury

Year	Exports Flasks	Exports Value (thousands)	Reexports Flasks	Reexports Value (thousands)
1970	4,653	$2,133	50	$19
1971	7,232	2,789	--	--
1972	400	129	563	121

Table 11.—U.S. imports for consumption [1] of mercury, by country

Country	1970 Flasks	1970 Value (thousands)	1971 Flasks	1971 Value (thousands)	1972 Flasks	1972 Value (thousands)
Algeria	--	--	--	--	3,007	$1,075
Belgium-Luxembourg	--	--	2	$2	--	--
Canada	17,872	$7,140	18,198	5,477	13,803	2,686
Colombia	--	--	400	101	--	--
Germany, West	(2)	(2)	203	49	--	--
Hungary	--	--	--	--	100	17
Italy	1,101	560	250	75	--	--
Japan	--	--	3	(2)	2	(2)
Mexico	920	386	4,786	1,160	5,529	941
Netherlands	--	--	--	--	53	24
Norway	--	--	--	--	[3] 1,329	305
Peru	14	6	600	155	1,461	310
Philippines	--	--	--	--	100	23
Spain	2,002	945	2,152	659	1,829	438
Sweden	12	4	--	--	7	17
Switzerland	1	1	5	8	14	22
Turkey	--	--	1,430	366	450	102
United Kingdom	50	26	--	--	53	13
Yugoslavia	--	--	420	113	1,097	238
Total	21,972	9,068	28,449	8,165	28,834	6,211

[1] General imports in 1970 were 21,672 flasks ($8,962,335); Spain supplied 1,702 flasks ($805,504). In 1971, 29,750 flasks ($8,500,607) were imported; Spain supplied 3,353 flasks ($970,028) and Mexico, 4,886 flasks ($1,184,826). In 1972 imports comprised 29,179 flasks ($6,232,570); Peru supplied 2,210 flasks ($458,495), Yugoslavia 1,402 flasks ($298,345), and Spain 1,120 flasks ($254,677).
[2] Less than ½ unit.
[3] Reclaimed metal.

plus material entering the country under bond, were 29,179 flasks. The major suppliers were Canada, 48%; Mexico, 19%; Algeria, 10%; and Spain, 6%. Smaller amounts of prime virgin metal came from Peru, Turkey, and Yugoslavia. Ore containing about 2 flasks of metal was imported from Peru. Trade in mercury compounds, including cinnabar concentrate, was small. Included in the import figures are 1,329 flasks entering the country as secondary metal from Norway and 2 flasks contained in scrap from Mexico.

The U.S. rate of duty on mercury imports during the year was $9.50 per flask.

WORLD REVIEW

World mercury production decreased to 279,508 flasks from 298,552 flasks in 1971. Spain, the U.S.S.R., and Italy were the three largest producers, accounting for 55% of the total. Canada, Italy, and Spain curtailed production during the year in the face of soft prices, slackening demand, and in the case of the latter two, excessive metal inventory. Europe was rife with rumors that representatives of the industry from Algeria, Italy, Mexico, Spain, and Yugoslavia had met in France in December to discuss a base price for mercury.

Algeria negotiated contracts for the sale of its mercury production to firms in the United States, Europe, and Japan. The People's Republic of China, which in the past exported considerable volume of metal to the U.S.S.R., reportedly cut exports to meet higher home consumption and stockpiling objectives. Mercury mining in Turkey was reviewed from its beginning 8,000 years ago to the present.[5] Developments in other countries were as follows:

Table 12.—Mercury: World production, by country

(Flasks)

Country	1970	1971	1972 p
Algeria	--	7,136	e 1 9,200
Australia	37	9	e 6
Bolivia (exports)	12	--	--
Canada	24,400	2 18,500	2 14,600
Chile	388	502	e 500
China, People's Republic of e	20,000	26,000	26,000
Colombia	215	213	e 200
Czechoslovakia	4,815	5,628	e 5,800
Finland	e 100	135	e 300
Ireland	1,304	2,345	1,250
Italy	r 44,470	42,613	e 42,120
Japan	5,170	5,564	5,172
Mexico	r 30,256	35,390	22,510
Peru	r 3,196	3,390	3,066
Philippines	4,648	5,020	3,341
Spain	r 45,552	50,831	e 60,500
Tunisia	r 102	340	238
Turkey	8,592	10,460	e 11,000
U.S.S.R. e	48,000	50,000	50,000
United States	27,296	17,883	7,286
Yugoslavia	15,461	16,593	16,419
Total	r 284,014	298,552	279,508

e Estimate. p Preliminary. r Revised.
1 Production target set for 1972.
2 Output of Cominco Ltd.; excludes production (if any) by minor producers.

Canada.—Cominco Ltd., reduced its mercury production in midyear with the result that total production was 21% less than in 1971. Ore production from the Pinchi Lake mine amounted to 203,000 tons, compared with 248,000 tons in 1971. Assuming that all the ore mined was treated to produce metal, the ore grade declined from 5.7 pounds of mercury per ton in 1971 to 5.5 pounds in 1972. Ore reserves were reported by Cominco to be 1,800,000 tons containing 133,000 flasks of mercury.

[5] Wyllie, R. J. M., J. W. Barnes, and E. H. Bailey. Turkey's Major Mercury Mine Today and How It Was Mined 8,000 Years Ago. World Mining, v. 25, No. 4, April 1972, pp. 48–55.

Italy.—Monte Amiata Società Mineraria per Azioni, Italy's leading producer, reportedly cut its output of mercury during the year, but total Italian production was down only slightly from 1971 levels.

The company completed the deepening of the San Callisto pit at Abbadia San Salvatore and began working on the Garibaldi pit. In addition, Monte Amiata dug 2,800 feet of new tunnels and carried out about 330 feet of exploratory soundings.

Stabilimento Minerario del Siele, the second largest producer, also announced production cutbacks. A major part of the plant at Santa Fiora in the Province of Grosseto was closed.

Exports were only 9,631 flasks for the first 11 months compared with 15,201 flasks for all of 1971. Press releases in Italy reported that since domestic consumption of mercury declined substantially, much of the mercury output was stockpiled.

Mexico.—Output declined significantly because of the financial problems of Mercurio Mexicana, S.A. de C.V., the largest producer. As prices fell the company could not meet the costs of expanding its flotation mill or the payroll for its workers who eventually took over the mine. The company closed its mine in midyear and declared bankruptcy. Fomento Minero, the Mexican Bureau of Mines, was negotiating to reopen the mine under government control. Many small mines closed in the summer but started up again late in the year. About twelve of the largest producers formed an organization to avoid internal competition and to act as a marketing agent for foreign sales.

Spain.—Production increased by 19% to an estimated 60,500 flasks, even though two small producers closed their operations in midyear. Astur Belga de Minas, S.A., and Minas de la Soterrana, S.A., suspended operations and dismissed 330 workers to prevent financial losses to the companies. By yearend plans were underway to resume operations.

Minas de Almadén, the State-owned company, had several projects underway, including the installation of a conveyor belt system and the utilization of propane gas and automatic controls in the furnaces of the metallurgical plant.

Table 13.—Mercury: Exports from Italy, Spain, and Yugoslavia, by country
(Flasks)

Destinations	Italy			Spain			Yugoslavia		
	1970	1971	1972 [1]	1970	1971	1972	1970 [r]	1971	1972
Australia	30	30	NA	87	116	203	--	--	
Belgium-Luxembourg	--	752	1,099	2,321	290	--	--	1	
Bulgaria	698	256	NA	--	--	--	--	--	
Canada	--	--	NA	667	29	754	--	--	
Colombia	(2)	341	NA	203	1,189	290	--	--	
Czechoslovakia	--	--	NA	580	--	--	900	840	
Ecuador	--	--	--	--	--	--	--	450	
France	600	1,141	392	3,423	1,711	2,408	362	362	
Germany, East	4,353	2,102	NA	1,799	9,138	2,002	--	1	
Germany, West	1,111	5,300	2,002	13,924	6,672	3,423	2,075	1,589	
Greece	--	10	NA	--	3	29	--	3,081	
Hungary	--	--	NA	377	--	174	--	--	
India	--	--	NA	2,611	841	3,278	--	--	NA
Japan	2,277	400	NA	6,788	841	3,539	--	--	
Netherlands	1,731	534	NA	174	986	377	--	--	
Poland	--	921	NA	1,276	1,508	696	--	300	
Portugal	--	350	NA	667	261	145	--	--	
Romania	150	1,960	899	493	--	899	--	--	
South Africa, Republic of	--	--	NA	377	812	986	--	--	
Sweden	--	--	NA	1,392	2,176	2,175	535	210	
Switzerland	--	--	NA	1,189	348	580	553	600	
Taiwan	--	--	NA	2,292	493	203	--	--	
United Kingdom	3,267	801	3,002	290	1,653	6,759	1,512	1,200	
United States	1,101	250	NA	1,682	3,336	1,044	4,729	5,621	
U.S.S.R	--	--	NA	--	--	--	2,610	--	
Other countries and undistributed	172	53	[3] 2,237	668	234	609	654	30	
Total	15,490	15,201	9,631	43,280	32,637	30,573	13,930	14,285	13,692

[r] Revised. NA Not available.
[1] Data for first 11 months only. Source gives only a partial distribution of total. Many recipient countries are not listed separately; the total for all such countries is listed under "Other countries and undistributed."
[2] Less than ½ unit.
[3] Includes 1,001 flasks to Austria.

U.S.S.R.—Plans have been approved to build a large mercury mining and metallurgical complex near Magadan on the Chukota Peninsula. Commercial quantities of cinnabar were proved in the area, which has recently had an increasing production of mercury.

TECHNOLOGY

Because of the concern over the level of mercury in the environment, available data on mercury content in rocks, ores, minerals, soil, water, and plants were compiled with a view toward elucidating the role of natural processes in releasing mercury to the environment. The cycle of interconversions for mercury in nature shows that all of the oxidation states are readily interconvertible given the appropriate physical, chemical, and biological conditions.[6]

A process was developed by Bunker Hill Co. to remove mercury from the sulfuric acid produced from roasting zinc ores.[7] Details of the process have not been disclosed, to protect its patentability. In the Netherlands, quantities of mercury are being extracted from the Groningen natural gas field.[8] The company is installing equipment for the industrial recovery of more mercury found with solid contaminants, including sand and clay.

A method of determining traces of mercury in liquids, sensitive to about 1 part per billion, was developed.[9] After selectively adsorbing the mercury on gold foil, it is heated to release the mercury vapor in an inert gas mixture where it is detected by a fluorescence spectrometer.

Interest continued on the development of methods for the removal of mercury from industrial waste solutions. In one system, high-molecular-weight amines are used to extract mercury quantitatively from alkaline as well as acidic brine solutions.[10] Regeneration of the amine solvent is readily achieved by stripping the mercury with aqueous solutions of nitric acid or other amines, or reduction of the mercury to metal by aluminum. A process capable of reducing the mercury content of waste water to less than 5 parts per billion utilizes an ion exchange resin.[11] Passage through the resin reduces the mercury content of the water from about 20 parts per million (ppm) to 0.1 ppm. The resulting effluent is subsequently treated through a second patented resin to reduce further the mercury content. The ion exchange resin is regenerated and metallic mercury is recovered. Treatment of the brine-settler mud in chlorine plants involves leaching with hypochlorite solution to form a soluble mercury complex and passage of the solution through ion exchange resins to recover the mercury. Mercury in vapors emerging from chlor-alkali plants has been successfully removed by scrubbing with an alkaline sodium hypochlorite-sodium chloride solution[12] or by passing the gas through molecular sieves.[13]

At the Bureau of Mines Reno Metallurgy Research Center, Reno, Nev., mercury extractions of 98% were obtained in pilot plant studies using the patented electrooxidation process on cinnabar ore from the Cordero mine, McDermitt, Nev.[14] A sample of Peruvian ore containing 1.8 pounds of mercury per ton was treated with the achievement of 94% extraction efficiency. A chemically modified cellulose was developed which appears highly effective for removing mercuric ions from water over a wide pH range, and in the presence of other metal ions and complexing agents.

Several new uses for mercury were publicized during the year. A method was developed using molten mercuric bromide as a heavy liquid in the separation of high-density minerals, such as uraninite from zircon in artificial mixtures.[15] An electro-

[6] Jonasson, I. R., and R. W. Boyle. Geochemistry of Mercury and Origins of Natural Contamination of the Environment. Canadian Min. and Met. Bull., v. 65, No. 717, January 1972, pp. 32–39.

[7] Chemical Engineering. V. 79, No. 23, Oct. 16, 1972, p. 51.

[8] Petroleum and Petrochemical International. V. 12, No. 8, August 1972, pp. 40, 45.

[9] Chemical and Engineering News. V. 50, No. 42, Oct. 16, 1972, p. 11.

[10] Moore, F. L. Solvent Extraction of Mercury From Brine Solutions With High-Molecular-Weight Amines. Environmental Science and Technology, v. 6, No. 6, June 1972, pp. 525–529.

[11] Engineering and Mining Journal. V. 173, No. 6, June 1972, p. 182.

[12] Chemical and Engineering News. V. 50, No. 4, Jan. 24, 1972, p. 12.

[13] Chemical Week. V. 3, No. 24, Dec. 13, 1972, p. 45.

[14] Scheiner, B. J., R. F. Lindstrom, and T. A. Henrie (assigned to U.S. Department of the Interior). Extraction of Mercury From Mercury-Bearing Materials. U.S. Pat. 3,639,222, Feb. 1, 1972.

[15] Grandstaff, P. E. Use of Mercuric Bromide as a Heavy Liquid. Am. Mineral., v. 57, Nos. 11–12, Nov.-Dec. 1972, pp. 1899–1902.

chemical method for the preparation of mercury telluride, which is an excellent infrared detector material, was described.[16] Research is being conducted on the use of a mercury cathode in the electrolysis of aqueous solutions of copper to produce the powder.[17] The same technique should be possible with other metals that are insoluble in mercury, such as nickel and iron.

A survey of the mercury reprocessing industry was undertaken by the Oak Ridge National Laboratory to obtain a better understanding of the technology and economics of recycling.[18] It was found that about one-third of the secondary mercury came from instruments and electrical apparatus, about one-quarter each from research laboratories and industrial scrap, about one-tenth from batteries, and the remainder from miscellaneous sources.

---

[16] Miles, M. H. Electrochemical Preparation of Cadmium and Mercury Tellurides. J. Electrochem. Soc., v. 119, No. 9, September 1972, pp. 1188–1190.

[17] Morris, T. M. Electrowinning of Metals With a Mercury Cathode. Pres. at Joint Meeting MMIJ-AIME, Tokyo, Japan, May 24–27, 1972, AIME Preprint T4C1, 8 pp.

[18] Clark, W. E., and W. Fulkerson. Survey of the Mercury Reprocessing Industry 1968–1970. ORNL NSF-EP-22 (Oak Ridge National Laboratory, Oak Ridge, Tenn.), October 1972, 13 pp.

Mica

By Benjamin Petkof [1]

Scrap and flake mica production reached the highest output ever recorded in the United States during 1972. Only a minor quantity of low-quality sheet mica was produced during the year in only one State. Ground mica production increased in both quantity and value. All exports of mica declined in quantity but increased in value. Imports of unprocessed and processed sheet increased, and scrap imports declined. The domestic consumption of all forms of sheet mica varied little from that of the previous year.

Table 1.—Salient mica statistics

	1968	1969	1970	1971	1972
United States:					
Sold or used by producers:					
Sheet mica____thousand pounds__	15	W	--	17	14
Value____thousands__	W	$3	--	$7	$7
Scrap and flake mica_thousand short tons__	125	133	119	127	160
Value____thousands__	$3,014	$2,893	$2,527	$2,917	$4,353
Ground mica____thousand short tons__	111	125	115	120	128
Value____thousands__	$7,072	$8,058	$7,350	$8,280	$8,844
Consumption, block and film thousand pounds__	1,628	1,498	1,299	1,301	1,207
Value____thousands__	$2,591	$2,595	$2,058	$2,259	$2,026
Consumption, splittings____thousand pounds__	4,785	5,077	5,214	4,177	4,324
Value____thousands__	$2,010	$2,196	$2,254	$1,818	$1,771
Exports____thousand short tons__	14	6	9	8	7
Imports for consumption____do____	5	5	6	7	5
World: Production____thousand pounds__	346,513	367,635	360,768	375,554	440,016

W Withheld to avoid disclosing individual company confidential data.

DOMESTIC PRODUCTION

Sheet Mica.—Slightly over 7 short tons of sheet mica, valued at $7,000, was produced in Colorado during 1972. The production consisted of low-value punch and circle mica. The outlook for any large future production of any quality of sheet mica remained small.

Scrap and Flake Mica.—The production of scrap and flake mica reached an alltime high of 159,536 short tons valued at $4,353,313. This was an increase of 26% in quantity and 49% in value. North Carolina was the major scrap and flake producing State with almost 57% of total production. The remaining output came from Alabama, Arizona, Connecticut, Georgia, New Mexico, Pennsylvania, South Dakota, and South Carolina. Flake mica was obtained primarily by the beneficiation of material from pegmatite and kaolin deposits. The domestic output of scrap and flake was processed to small particle size mica for various industrial end uses.

Ground Mica.—Sales of ground mica increased 7% in both quantity and value over those of 1971. Dry-ground mica accounted for 80% of total sales. Sixteen companies, operating a total of 20 plants, processed scrap and flake to a small particle size; of these plants, 14 produced dry-ground mica; 3, wet-ground; and 3, both wet- and dry-ground.

[1] Physical scientist, Division of Nonmetallic Minerals.

Table 2.—Mica sold or used by producers in the United States

Year and State	Sheet mica: Uncut punch and circle mica		Sheet mica: Uncut mica larger than punch and circle		Sheet mica: Total sheet mica		Scrap and flake mica [1]	
	Pounds	Value	Pounds	Value	Pounds	Value	Short tons	Value
1968	--	--	15,000	W	15,000	W	125,323	$3,013,855
1969	W	$3,244	--	--	W	$3,244	133,058	2,893,183
1970	--	--	--	--	--	--	118,843	2,527,450
1971	17,005	6,652	--	--	17,005	6,652	127,084	2,916,879
1972:								
Colorado	14,280	7,140	--	--	14,280	7,140	--	--
Connecticut	--	--	--	--	--	--	2,446	W
New Mexico	--	--	--	--	--	--	14,000	W
North Carolina	--	--	--	--	--	--	90,743	2,941,809
Other [2]	--	--	--	--	--	--	52,347	1,411,504
Total	14,280	7,140	--	--	14,280	7,140	159,536	4,353,313

W Withheld to avoid disclosing individual company confidential data, included with "Other."
[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, Arizona, Georgia, Pennsylvania, South Carolina, South Dakota, and states indicated by symbol W.

Table 3.—Ground mica sold by producers in the United States by method of grinding [1]

Year	Dry-ground: Short tons	Dry-ground: Value (thousands)	Wet-ground: Short tons	Wet-ground: Value (thousands)	Total: Short tons	Total: Value (thousands)
1968	96,410	$4,862	14,979	$2,210	111,389	$7,072
1969	109,152	5,486	15,704	2,572	124,856	8,058
1970	101,188	5,070	13,905	2,280	115,093	7,350
1971	103,428	5,463	16,176	2,817	119,604	8,280
1972	102,625	5,500	25,649	3,343	128,274	[2] 8,844

[1] Domestic and some imported scrap.
[2] Data may not add to total shown because of independent rounding.

CONSUMPTION AND USES

Sheet Mica.— The consumption of all forms of sheet mica, consisting of block, film, and splittings varied only slightly from that of the previous year. Splittings were the major form of sheet mica consumed.

About 1.1 million pounds of block mica was consumed for the fabrication of vacuum tubes, capacitors, and various other electrical and nonelectrical items. Of the total consumption, vacuum tubes required 70% and capacitors accounted for 1%. Lower than Stained quality was in greatest demand and accounted for 64% of total consumption; Stained, 35%; and Good Stained or better, the remainder. Only a small quantity of mica film was consumed primarily for the fabrication of capacitors.

Muscovite block and film was consumed by 14 companies in Seven States. New Jersey with four consuming plants, New York with three, North Carolina with two, and Pennsylvania with one, consumed 77% of the domestically fabricated block and film mica. The consumption of phlogopite block increased 11% to 74,199 pounds.

Total consumption of splittings increased almost 4% from that of 1971. India and the Malagasy Republic continued to supply the bulk of the splittings consumed domestically. Splittings were fabricated into various built-up mica products by 10 companies with 11 plants in seven States. Four companies, with five plants located in New Hampshire, New York, Ohio, and Pennsylvania, consumed almost 3.6 million pounds of splittings or 83% of total consumption.

Built-up Mica.—This mica-based alternate material was produced in various forms, primarily for use as an electrical insulating material. The production of built-up mica products in 1972 declined 5% in quantity and 10% in value from

Table 4.—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 1972

(Pounds)

Variety, form, and quality	Electronic uses				Nonelectronic uses			Grand total
	Capacitors	Tubes	Other	Total	Gage glass and diaphragms	Other	Total	
Muscovite:								
Block:								
Good Stained or better	972	2,313	3,179	6,464	3,631	15	3,646	10,110
Stained	3,632	342,891	43,345	389,868	3,202	95	3,297	393,165
Lower than Stained [1]	7,425	436,786	135,213	579,424	20,250	118,168	138,418	717,842
Total	12,029	781,990	181,737	975,756	27,083	118,278	145,361	1,121,117
Film:								
First quality	2,133	420	260	2,813	307	--	307	3,120
Second quality	5,915	--	25	5,940	--	--	--	5,940
Other quality	2,450	--	--	2,450	--	--	--	2,450
Total	10,498	420	285	11,203	307	--	307	11,510
Block and film:								
Good Stained or better [2]	9,020	2,733	3,464	15,217	3,938	15	3,953	19,170
Stained [3]	6,082	342,891	43,345	392,318	3,202	95	3,297	395,615
Lower than Stained	7,425	436,786	135,213	579,424	20,250	118,168	138,418	717,842
Total	22,527	782,410	182,022	986,959	27,390	118,278	145,668	1,132,627
Phlogopite: Block (all qualities)	--	--	68	68	--	74,131	74,131	74,199

[1] Includes punch mica.
[2] Includes first- and second-quality film.
[3] Includes other-quality film.

Table 5.—Fabrication of muscovite ruby and nonruby block and film mica in the United States in 1972, by quality and grade

(Pounds)

Form, variety, and quality	Grade					
	No. 4 and larger	No. 5	No. 5½	No. 6	Other [1]	Total
Block:						
Ruby:						
Good Stained or better	3,200	1,123	336	877	--	5,536
Stained	11,218	50,812	80,016	224,916	11,830	378,792
Lower than Stained	7,543	88,340	115,897	277,912	168,012	657,704
Total	21,961	140,275	196,249	503,705	179,842	1,042,032
Nonruby:						
Good Stained or better	2,196	318	50	2,010	--	4,574
Stained	918	6,027	2,319	5,109	--	14,373
Lower than Stained	14,300	12,538	800	2,500	30,000	60,138
Total	17,414	18,883	3,169	9,619	30,000	79,085
Film:						
Ruby:						
First quality	690	475	350	380	--	1,895
Second quality	498	2,817	1,375	150	--	4,840
Other quality	--	--	--	--	2,450	2,450
Total	1,188	3,292	1,725	530	2,450	9,185
Nonruby:						
First quality	--	75	520	630	--	1,225
Second quality	--	--	1,100	--	--	1,100
Other quality	--	--	--	--	--	--
Total	--	75	1,620	630	--	2,325

[1] Figures for block mica include all smaller than No. 6 grade and "punch" mica.

Table 6.—Consumption and stocks of mica splittings in the United States, by source

(Thousand pounds and thousand dollars)

	India		Malagasy		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
Consumption:						
1968	4,579	1,874	206	136	4,785	2,010
1969	4,799	2,005	278	191	5,077	2,196
1970	5,013	2,109	202	144	[1] 5,214	[1] 2,254
1971	4,084	1,750	93	68	4,177	1,818
1972	4,245	1,658	79	113	4,324	1,771
Stocks Dec. 31:						
1968	2,469	NA	149	NA	2,618	NA
1969	2,415	NA	145	NA	2,560	NA
1970	W	NA	W	NA	2,013	NA
1971	1,317	NA	98	NA	1,415	NA
1972	1,723	NA	86	NA	1,809	NA

NA Not available. W Withheld to avoid disclosing individual company confidential data.
[1] Data may not add to total shown because of independent rounding.

Table 7.—Built-up mica [1] sold or used in the United States, by product

(Thousand pounds and thousand dollars)

Product	1971		1972	
	Quantity	Value	Quantity	Value
Molding plate	698	2,102	851	2,369
Segment plate	993	2,072	1,125	2,394
Heater plate	W	W	W	W
Flexible (cold)	520	1,031	468	971
Tape	1,165	4,253	957	3,239
Other	596	1,499	357	934
Total	[2] 3,971	10,957	[2] 3,757	9,907

W Withheld to avoid disclosing individual company confidential data, included with "Other."
[1] Consists of alternate layers of binder and irregularly arranged and partly overlapped splittings.
[2] Data may not add to total shown because of independent rounding.

Table 8.—Ground mica sold by producers in the United States, by use

Use	1971		1972	
	Short tons	Value (thousands)	Short tons	Value (thousands)
Roofing	17,835	$669	18,798	$650
Wallpaper	W	W	492	79
Rubber	5,284	876	5,589	W
Paint	26,807	2,710	27,115	2,816
Plastics	479	93	497	96
Welding rods	W	W	W	W
Joint cement	45,230	2,977	52,111	3,308
Other [1]	23,969	956	23,672	1,894
Total	119,604	[2] 8,280	128,274	[2] 8,844

W Withheld to avoid disclosing individual company confidential data, included with "Other."
[1] Includes mica used for molded electric insulation, annealing, well drilling, textile and decorative coating, texture paint, and uses indicated by symbol W.
[2] Data may not add to totals shown because of independent rounding.

that of the previous year. The forms of built-up mica in greatest demand was segment plate (30%), tape (25%), and molding plate (23%).

Reconstituted Mica.—Three companies continued to manufacture this mica-based alternate material from good-quality delaminated scrap mica. The manufacturing companies were the General Electric Co. at Schenectady, N.Y., the Samica Corp. at Rutland, Vt., and the Acim Paper Corp. at New Hyde Park, N.Y. There were no data available relating to the quantity and value of the reconstituted mica produced during the year.

STOCKS

At yearend there was about 2.5 million pounds of sheet mica in fabricators' stocks. Of this quantity, 73% was splittings, and the remainder was almost entirely of block. Only a minor quantity consisted of film. This information was obtained by direct canvass of fabricators of sheet mica. Similar information is not available for scrap and flake mica, but it is thought that producers maintain stock inventories equal to 5% or 10% of domestic production.

PRICES

The average value of the domestically produced uncut punch ad circle mica in 1972 was $0.50 per pound, an increase of $0.11 per pound over that of the previous year. The average value of muscovite sheet mica in 1972, based on consumption data, was as follows: block, $1.62 per pound; film $6.70 per pound; and splittings, $0.41 per pound. The average value of phlogopite sheet mica, also based on consumption data, was as follows: phlogopite block, $1.84 per pound and phlogopite splittings, $1.43 per pound.

The average value of scrap and flake mica produced during the year was $27.29 per ton. Prices for ground mica, prepared from scrap and flake, quoted in the Chemical Marketing Reporter were essentially unchanged from the previous year. Yearend prices are shown in table 9.

Table 9.—Price of dry-or wet-ground mica in the United States in 1972[1]

	Cents per pound
Dry-ground:	
Joint cement, 100 mesh	3¾–5
Plastic, 100 mesh	3¾–5
Roofing, 20 to 80 mesh	2–3
Wet-ground:[2]	
Paint or lacquer, 325 mesh	9
Rubber	9
Wall paper	10

[1] In bags at works, carlots, unless otherwise noted.
[2] Freight allowed east of the Mississippi River, ½ cent higher west of the Mississippi River, 1 cent higher west of the Rockies.

Source: Chemical Marketing Reporter. V. 203, No. 1, Jan. 1, 1973.

FOREIGN TRADE

All classes of mica exports declined 1% in quantity but increased 26% in value from that of the previous year. Almost 70% of the sheet, scrap and flake, and ground mica exported, was shipped to Canada, France, Japan, and Venezuela. Reported export data do not provide information on the grade or type of mica exported but it is assumed that the major portion of the material exported is ground mica.

Imports of scrap and waste mica declined 64% in both quantity and value. Imports of sheet mica increased slightly in quantity but declined slightly in value. Processed mica imports increased 26% in quantity and 29% in value.

Table 10.—U.S. exports of mica and manufactures of mica, by country

Destination	Mica, including block, film and splittings, waste and scrap, and ground mica		Manufactured	
	Pounds	Value (thousands)	Pounds	Value (thousands)
Argentina	77,600	$11	18,465	$42
Australia	54,541	5	10,373	42
Belgium-Luxembourg	63,000	5	4,060	21
Bolivia	84,000	8	--	--
Brazil	--	--	53,357	123
Canada	6,293,821	523	357,849	1,014
Chile	13,838	2	982	4
Colombia	95,682	13	1,067	6
Denmark	--	--	8,484	23
Dominican Republic	44,000	5	1,332	5
France	1,126,200	72	13,267	74
Germany, West	588,922	98	4,945	14
Hong Kong	154,041	64	--	--
Iran	101,100	10	616	2
Italy	418,539	58	50,977	172
Jamaica	38,000	2	51,034	400
Japan	1,188,843	564	19,474	54
Mexico	95,337	10	294,769	641
Netherlands	854,562	49	1,955	9
Norway	110,000	6	--	--
Peru	20,500	5	1,030	3
Philippines	51,300	8	121	1
Singapore	169,600	14	580	2
South Africa, Republic of	20,000	1	4,295	10
Spain	177,570	20	7,834	40
Sweden	48,375	13	24,872	32
Switzerland	141,347	17	189	1
Taiwan	4,863	17	2,334	24
Trinidad and Tobago	--	--	5,154	11
United Arab Emirates	278,150	31	--	--
United Kingdom	411,594	122	45,421	91
Venezuela	1,093,200	74	1,334	8
Other	138,788	15	15,469	41
Total	13,957,313	1,842	1,001,639	2,910

Table 11.—U.S. exports and imports of mica

(Thousand pounds and thousand dollars)

Year	Exports		Imports for consumption					
	All classes		Uncut sheet and punch		Scrap		Manufactured	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1970	18,721	4,732	875	966	6,048	136	4,530	2,549
1971	15,182	3,768	1,355	1,171	7,284	171	4,464	2,476
1972	14,959	4,752	1,494	1,162	2,641	62	5,644	3,183

Table 12.—U.S. imports for consumption of mica, by kind and country

Year and Country	Unmanufactured [1]									
	Waste and scrap						Other			
	Phlogopite		Other		Block mica		Muscovite		Other, n.e.c.	
	Pounds	Value (thousands)	Pounds	Value (thousands)	Pounds	Value (thousands)	Pounds	Value (thousands)	Pounds	Value (thousands)
1970	380,619	$13	5,667,328	$123	681,134	$690	48,981	$105	144,550	$171
1971	188,107	4	7,096,451	167	989,393	902	207,945	54	158,437	215
1972:										
Brazil	--	--	132,276	3	738,256	756	--	--	39,528	89
Canada	--	--	--	--	--	--	--	--	160,900	3
France	--	--	--	--	1,543	2	--	--	2,425	6
Hong Kong	--	--	--	--	13	(2)	--	--	20	1
India	--	--	2,375,220	55	151,099	180	109,502	3	5,440	16
Jamaica	--	--	--	--	--	--	--	--	5,193	(2)
Malagasy Republic	112,000	4	--	--	4,048	6	--	--	273,205	75
Mexico	--	--	21,903	(2)	--	--	--	--	--	--
Nepal	--	--	--	--	--	--	266	1	--	--
Tanzania	--	--	--	--	702	2	--	--	1,371	15
United Kingdom	--	--	--	--	--	--	--	--	269	7
Total	112,000	4	2,529,399	58	895,661	946	109,768	4	488,351	212

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	
	Pounds	Value (thousands)	Pounds	Value (thousands)	Pounds	Value (thousands)	Pounds	Value (thousands)
1970	4,244,832	$1,310	31,938	$63	72,067	$888	85,657	$143
1971	4,065,125	1,134	52,271	42	79,711	1,013	113,105	180
1972:								
Brazil	--	--	2,971	5	407	7	114	1
Canada	3,746	2	--	--	207	1	--	--
France	661	2	--	--	319	1	--	--
Haiti	--	--	65	1	1,633	15	--	--
India	4,380,119	1,050	560	3	88,786	1,342	103,423	150
Malagasy Republic	116,092	52	2,976	7	2,546	15	--	--
Mexico	--	--	--	--	397	16	110	1
South Africa, Republic of	--	--	--	--	--	--	1,308	3
Taiwan	25,000	5	--	--	1,207	33	--	--
Tanzania	350	3	--	--	--	--	--	--
United Kingdom	1,000	3	--	--	614	15	771	10
Uruguay	35,000	6	--	--	--	--	--	--
Total	4,561,968	1,123	6,572	16	96,116	1,445	105,726	165

Year and Country	Mica plates and built-up mica		Ground or pulverized		Articles not especially provided for of mica	
	Pounds	Value (thousands)	Pounds	Value (thousands)	Pounds	Value (thousands)
1970	79,258	$90	4,480	$1	12,464	$54
1971	29,198	32	105,820	2	19,383	73
1972:						
Belgium-Luxembourg	229,591	189	--	--	396	(2)
Canada	3,952	17	--	--	576	(2)
France	--	--	--	--	543,300	73
Germany, West	60,881	68	--	--	--	--
India	--	--	22,046	(2)	9,259	51
Netherlands	--	--	--	--	333	17
Switzerland	--	--	--	--	150	(2)
United Kingdom	--	--	--	--	2,970	19
Total	294,424	274	22,046	(2)	556,984	160

[1] In addition to classes shown for 1970, of untrimmed phlogopite from which no piece over 2 by 1 inch may be cut was 33,069 pounds ($705) from Brazil; none in 1971 and 1972.
[2] Less than ½ unit.

WORLD REVIEW

World mica production remained strong during the year with major producing countries continuing to maintain their output. India and the Malagasy Republic remained the major producers of sheet muscovite and phlogopite respectively. The United States dominated the area of scrap and flake production.

India.—On January 25, 1972, the Indian Government announced that all mica exports were to be channelled through the Minerals and Metals Trading Corp. of India (MMTC). The MMTC was expected to purchase mica from small mine owners for export. The corporation does not control exports of manufactured, fabricated, built-up, reconstituted, or ground mica. In April 1972, MMTC agreed to consider requests from private mica exporters to negotiate sales directly. Exporters with current contracts or agreements with foreign buyers were permitted to function as previously, but on behalf of MMTC and at current minimum prices. An additional proviso stipulated that all letters of credit were to be made to the favor of MMTC.

During 1972, 422 privately owned mines reported production. About 100 of these mines claimed that their production was in excess of 50 short tons per year. The output of the remaining mines, which were essentially cottage industry-type operations, varied from 5 to 30 tons per year, each. Hand-mining methods were used in open pits throughout the industry where operations rarely exceeded depths of 50 feet.

Table 13.—Mica: World production by country

(Thousand pounds)

Country [1]	1970	1971	1972 [p]
Argentina:			
Sheet	[r] 198	340	[e] 330
Waste, scrap, etc	[r] 2,897	6,400	[r] 6,600
Bolivia	13	--	--
Brazil [2]	4,451	5,298	[e] 5,300
Ceylon	1,032	694	428
Colombia	57	71	84
France	[r] 6,830	[e] 6,800	[e] 6,800
India:			
Exports:			
Block [3]	3,616	2,915	3,309
Splittings [4]	14,756	13,832	14,235
Scrap [5]	41,026	35,891	38,354
Domestic consumption, all classes [e]	13,200	17,600	18,700
Total [e]	72,598	70,238	74,598
Malagasy Republic (phlogopite):			
Block	86	74	127
Splittings	1,935	978	751
Scrap	42	244	413
Mexico	1,235	1,561	[e] 1,565
Mozambique (including scrap)	557	2,094	[e] 2,100
Norway (including scrap) [2]	9,586	7,668	[e] 6,600
Portugal	4,266	1,786	3,651
South Africa, Republic of:			
Sheet	24	7	4
Scrap	16,647	15,785	9,359
Tanzania:			
Sheet	99	81	50
Scrap	28	[e] 29	[e] 29
United States:			
Sheet	--	17	14
Scrap and flake	237,686	254,168	320,000
Yugoslavia	501	1,221	[e] 1,213
Total	[r] 360,768	375,554	440,016

[e] Estimate. [p] Preliminary. [r] Revised.

[1] In addition to the countries listed, the People's Republic of China, Romania, Southern Rhodesia, South-West Africa, Sweden and the U.S.S.R. are known to produce mica, but available information is inadequate to make reliable estimates of output levels.

[2] Exports.

[3] Includes micanite and other built-up.

[4] Includes condenser film, washer, and discs.

[5] Includes sheets, strips, and powder.

Crude mica production, based on exports plus consumption, increased slightly from 35,119 tons in 1971 to 37,299 tons in 1972. Exports also increased from 26,319 tons valued at $21.7 million in 1971 to 27,949 tons valued at $25.3 million in 1972. Thirty-two percent of exports in both 1971 and 1972 consisted of sheet mica. The remainder consisted of other forms of processed and scrap mica.

TECHNOLOGY

The work of the Bureau of Mines in the area of recovery of mica concentrates by flotation from weathered mica pegmatites and micaceous schist ores has been reviewed. The acid cationic and alkaline anionic-cationic method for the recovery of coarse and fine mica, respectively, are discussed and flowsheets for their use were provided. In addition, mining, recovery, and grinding of mica were discussed.[2]

Batch laboratory scale tests were run on several industrial minerals that included mica to determine the optimum grinding constants. The test used an attrition grinding process developed previously by the Bureau of Mines.[3]

A method has been developed to break apart natural, synthetic, or mixtures of mica by initially heating the material to drive off the water of hydration. The heated material is then broken apart in oriented streams of an inert gas such as argon to produce thin, smooth-surfaced particles, or flakes with a high specific surface area and a high ratio of length to thickness.[4]

---

[2] Browning, James S. Mica Beneficiation. BuMines Bull. 662, 1973, 21 pp.

[3] Stanczyk, Martin H., and I. L. Feld. Ultrafine Grinding of Several Industrial Minerals by the Attrition Grinding Process. BuMines RI 7641, 1972, 25 pp.

[4] Ruzikk, J. Ultradisintegration of Natural or Synthetic Mica. U.S. Pat. 3,719,329, Mar. 6, 1973.

Molybdenum

By Andrew Kuklis [1]

World molybdenum output rose 4.4 million pounds in 1972 and was 2% higher than in 1971. Molybdenum remained in oversupply because of an increase in new production capacity that resulted in a significant rise in stocks during 1972. To arrest the alarming growth of stocks, some mines shutdown, and others reduced molybdenum production. Yearend world molybdenum stocks were estimated to exceed the current annual consumption rate.

Based upon known geological occurrences, production trends of the past decade, and current projects under development, the supply of molybdenum was expected to be adequate to meet increasing demand during the remaining years of the 20th century.

Table 1.—Salient molybdenum statistics

(Thousand pounds contained molybdenum and thousand dollars)

	1968	1969	1970	1971	1972
United States:					
Concentrate:					
Production	93,447	99,807	111,352	109,592	112,138
Shipments	93,245	103,009	110,381	97,882	102,197
Value	151,000	173,819	190,077	164,917	170,530
Consumption	75,647	73,275	76,101	66,399	62,560
Imports for consumption	1	(1)	25	854	385
Stocks, Dec. 31: Mine and plant	12,208	8,398	9,715	29,077	45,243
Primary products:					
Production	69,675	68,526	75,383	67,016	64,841
Shipments	63,761	77,726	76,095	66,654	75,538
Consumption	49,271	51,622	45,337	40,950	45,558
Stocks, Dec. 31: Producers	18,170	17,844	25,904	31,048	28,898
World: Production	[2] 144,771	[2] 159,470	181,429	170,840	175,256

[1] Less than 1 unit. [2] Free World.

Legislation and Government Programs.—The House Armed Services Committee approved a bill to dispose of molybdenum in the national stockpile. All the molybdenum in the stockpile was declared in excess of national emergency requirements because an adequate supply was available from domestic resources. However, because of other legislative matters, the House of Representatives did not take action on the bill. At yearend, molybdenum in the national stockpile totaled 46.8 million pounds, same as at yearend 1971. Approximately 5.5 million pounds of molybdenum was classed as sold but unshipped (table 3).

[1] Mining engineer, Division of Ferrous Metals.

Table 2.—U.S. Government molybdenum stockpile material inventories on December 31, 1972

(Thousand pounds contained molybdenum)

Type material	National (strategic) stockpile
Molybdenum, disulfide	22,750
Molybdenum, ferro	7,501
Molybdic oxide	11,050
Total	41,301

Table 3.—U.S. Government molybdenum stockpile material, sold but unshipped on December 31, 1972 [1]

(Thousand pounds contained molybdenum)

Type material	National (strategic) stockpile
Molybdenum, disulfide	5,467
Molybdic oxide	31
Total	5,498

[1] Not included in table 2.

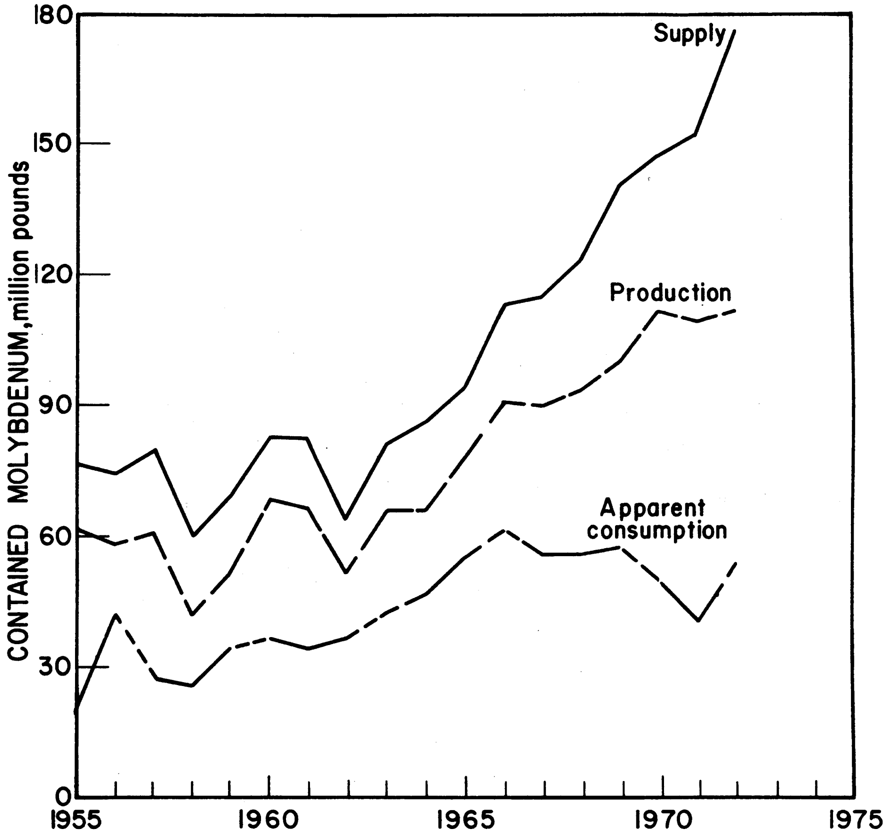

Figure 1.—Apparent consumption, production, and supply of molybdenum in the United States.

DOMESTIC PRODUCTION

Domestic output totaled 112.1 million pounds of molybdenum, 2% higher than in 1971. Production reached an alltime high exceeding by 786,000 pounds the previous record year in 1970. Molybdenum remained in oversupply because of declining exports in recent years and lower than anticipated domestic demand that resulted in a rise in stocks.

Molybdenum production from primary sources approximated that produced in 1971. Three operations mined over 21 million tons of ore containing from 4 to 7 pounds of molybdenum per ton. As in past years, the Climax mine in Colorado of American Metal Climax, Inc. (AMAX), was the world's largest producer.

Increased byproduct molybdenum production capacities at copper porphyry plants, especially those completed in 1971, resulted in an 8% higher output from these sources. Molybdenum production obtained from byproduct sources rose to 37% from the 35% reported in 1971, continuing the upward trend of past years. The significance of this trend is apparent when related to past molybdenum production data. For example, in 1967, molybdenum output from these sources accounted for only 26% of domestic production; hence, in 5 years the percent of molybdenum production from byproduct sources rose over 42%.

Byproduct molybdenum from copper porphyry ores was produced at 14 plants, one less than in 1971. The Esperanza facility of Duval Corp. was closed during the year. Seven plants reported increased output, and seven had lower production. Molybdenum recovery at uranium and tungsten operations increased by 6% and 2% respectively, compared with 1971. The byproduct plants reportedly processed over 70 million tons of ore containing from 0.3 to 1.2 pounds of molybdenum per ton.

Yearend molybdenum stocks at mines increased 5.3 million pounds at byproduct operations but decreased about 600,000 pounds at primary operations.

According to 1972 data, Pennzoil Co., parent company of Duval Corp. and Duval Sierrita Corp., was the leading domestic producer of byproduct molybdenum. Kennecott Copper Corp., with four operations, remained in second place. Other large producers of byproduct molybdenum were, in order of output, Magma Copper Co., The Anaconda Company, and American Smelting and Refining Co. (Asarco).

Pima Mining Co. completed expansion of mine and concentrator capacity near Tucson, Ariz. The capacity of the facility was increased from 40,000 tons to 54,000 tons per day. Ore reserves at yearend 1972 were reported at 240 million tons having an average grade of 0.5% copper and sufficient molybdenum to justify recovery.

Cities Service Co. was developing a low-grade copper-molybdenum deposit at a cost of about $100 million near Pinto Valley, 8 miles west of Miami, Ariz. Capacity of the open pit mining facility reportedly will exceed 40,000 tons of ore per day. Approximately 62,500 tons of copper and an undisclosed amount of molybdenum will be recovered from the ore. Mine and milling operations were expected to commence in mid-1974 and reach designed capacity in early 1975. Work projects underway during 1972 were construction of a mill and preproduction stripping.

Molybdenum Corp. of America (Molycorp) increased molybdenum recovery at its Questa operation over 9% compared with that of 1971. Increased output was due to higher molybdenum content of ore milled. Pit stripping operations were conducted in accordance with a restrictive mining plan adopted in mid-1971 to lower development costs. It was reported that uninterrupted mining operations after 1976 would necessitate an increase in pit development expenditures during 1974. Furthermore, an increase in such expenditures for continued development of the mine would be justified only if the present weak price trend of molybdenum was reversed.

AMAX was developing an open pit mine on its Climax molybdenum deposit to supplement current underground production at the Climax mine in Lake County, Colo. The $40 million investment will increase ore output to 60,000 tons per day, of which 43,000 tons would be from underground operations, and the remainder from the open pit. Approximately 185 million tons of low-grade ore (0.28% molybdenite) were added to reserves at the Climax deposit, ore which could not be economically mined by underground methods. Total ore reserves reportedly were estimated at 500 million tons having an average grade of 0.35% molybdenite. About 260 million tons of waste material will be removed to develop the open pit mine. The combined open pit and underground operation will increase the flexibility of the Climax mine in meeting fluctuations in molybdenum demand. AMAX operations were described.[2]

Mine development continued at AMAX's Henderson molybdenum mine near Empire, Colo. The No. 2 shaft, a 28-foot-diameter unit, was bottomed out at 3,100 feet on June 14 by Harrison Western Corp., an international mine development contractor. A main ore haulage level was constructed at the 7500 elevation level where ore will be loaded into railroad cars for transportation through the tunnel to the mill. Good progress was reportedly made in driving a 9.3-mile ore haulage tunnel. At yearend, construction was conducted from two directions, from the underground mine and from the surface on the western slope. The $250 million mine and mill facility ultimately will produce 50 million pounds of molybdenum annually.

Commercial-ore-grade material was encountered by underground tunneling and drilling at the Thompson Creek molybdenum deposit in central Idaho by Cyprus Mines Corp. The company reported that the deposit contains about 100 million tons of ore assaying 0.148% molybdenite. Additional feasibility studies were underway re-

[2] Engineering and Mining Journal. AMAX in Perspective. V. 173, No. 9, September 1972, pp. 93–103.

garding the economics and time frame for developing the property.

Phelps Dodge Corp. negotiated a joint exploration agreement with Catla Mine Inc. on a copper-molybdenum mineralization in northern Elko County, Ariz. Catla Mine Inc. owns 471 mineral claims in the area and conducted considerable exploratory drilling in past years. An estimated 8 million tons of ore averaging 2.3% copper equivalent was reportedly drilled out on the leases.

At yearend, the copper-molybdenum mine and mill of Duval Sierrita Corp., Tucson, Ariz., reached designed capacity. The mill reportedly processed an average of 84,000 tons of ore daily during November and December. It was expected that the production potential of the facility would be reached during 1973. The $165 million mining, milling, and roasting complex commenced operations at midyear 1970.

Table 4.—Production, shipments, and stocks of molybdenum products in the United States

(Thousand pounds contained molybdenum)

	1971	1972	1971	1972	1971	1972
	Molybdic oxide [1]		Metal powder		Ammonium molybdate	
Received from other producers	3,823	7,591	12	21	11	651
Gross production during year	74,043	95,734	2,619	4,109	2,961	4,539
Used to make other products listed here	24,124	47,800	201	472	1,261	3,484
Net production	49,918	47,934	2,418	3,637	1,700	1,055
Shipments	48,383	55,720	2,481	3,578	1,498	2,738
Producer stocks, Dec. 31	24,279	23,701	491	580	760	560
	Sodium molybdate		Other [2]		Total	
Received from other producers	43	200	2,426	385	6,315	8,848
Gross production during year	879	1,116	14,301	14,255	94,803	119,753
Used to make other products listed here	14	5	2,187	3,151	27,787	54,912
Net production	865	1,111	12,115	11,104	67,016	64,841
Shipments	896	1,149	13,396	12,353	66,654	75,538
Producer stocks, Dec. 31	143	292	5,375	3,765	31,048	28,898

[1] Includes molybdic oxide, briquets, molybdic acid, and molybdenum trioxide.
[2] Includes ferromolybdenum, calcium molybdate, phosphomolybdic acid, molybdenum disulfide, pellets, molybdenum pentachloride, and molybdenum hexacarbonyl.

Table 5.—Consumption of molybdenum materials by end use in 1972

(Thousand pounds contained molybdenum)

End use	Molybdic oxides	Ferro-molybdenum [1]	Ammonium and sodium molybdate	Other molybdenum materials [2]	Total
Steel:					
Carbon	1,024	201	--	11	1,236
Stainless and heat resisting	4,111	1,688	--	63	5,862
Full alloy	15,284	1,529	--	107	16,920
High-strength low-alloy	2,466	481	--	7	2,954
Electric	907	89	--	--	996
Tool	2,097	974	--	31	3,102
Cast irons	734	2,764	--	180	3,678
Superalloys	770	323	--	1,283	2,376
Alloys (excludes steels and superalloys):					
Welding and alloy hard-facing rods and materials	--	317	--	18	335
Other alloys[3]	70	486	--	169	725
Mill products made from metal powder	--	--	--	2,467	2,467
Chemical and ceramic uses:					
Pigments	657	--	439	22	1,118
Catalysts	1,442	--	W	--	1,442
Other	412	--	22	786	1,220
Miscellaneous and unspecified	189	125	425	388	1,127
Total	30,163	8,977	886	5,532	45,558
Consumer stocks Dec. 31	2,194	1,586	116	1,000	4,896

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.

CONSUMPTION AND USES

Domestic consumption of molybdenum in concentrate declined nearly 6% compared with 1971 figures. Most of the concentrate, except that consumed in producing purified molybdenum disulfide, was converted to molybdic oxide for use as such or to produce other molybdenum products. Output of purified molybdenum disulfide for lubricants increased significantly compared with that of 1971.

Domestic end use consumption of molybdenum material rose 4.6 million pounds in 1972 and was about 11% higher than in 1971 (table 5). The increase was the first in 2 years, but remained about 12% below the record year of 1969. Higher consumption was due to increased production of alloy steel. Over 84% of molybdenum products were consumed by the iron and steel industry, the remainder for metal powder and in chemical uses. Steel manufacturers take advantage of unique properties such as hardenability, corrosion resistance, strengthening, and toughness that molybdenum conveys to various types of steel. In the metal powder and chemical markets, molybdenum products were consumed to produce specialty metal products, catalysts, and pigments. Molybdenum consumed in its various end uses was in the form of molybdic oxide (66%), ferromolybdenum (20%), ammonium and sodium molybdate (2%), and other materials (12%).

Development of new markets to increase consumption of molybdenum products was intensified, especially in alloy steel and for chemical applications.

The new high-strength steel containing molybdenum-columbium introduced in 1971 for manufacture of gas transmission pipe continued to gain acceptance in 1972. Two Canadian pipeline companies utilized approximately 200 miles of this line pipe for transporting natural gas to consumers and field tests for similar applications were being conducted in other countries.

A new 18% chromium, 2% molybdenum stainless steel was produced commercially by steel companies in the United States and abroad for use in hot water heaters, heat exchangers, and other applications where heat and corrosion problems exist. The molybdenum-type stainless steel has superior properties to nickel-type material for some applications, and in addition, it is lower in raw material costs.

A special grease-grade molydisulfide product was marketed in 1972. The product was reportedly easier to use than the present grade and permits grease manufacturers to reduce compounding costs.

A major paint and pigment company adopted a new "White Moly" product in manufacturing pigments. The material was developed by AMAX for nontoxic corrosion-inhibitive coating systems and designed for solvent-based paints in a wide range of colors. In addition to being nontoxic, White Moly was cost competitive with existing toxic materials on an equal cost basis.

STOCKS

The industrial molybdenum inventory, reported to the Bureau of Mines, was 79.0 million pounds, comprised of 45.2 million pounds at mines and plants, 28.9 million pounds at producer plants, and 4.9 million pounds at consumer plants. Molybdenum in stock at mines and plants rose nearly 56%, those at consumer plants rose over 22%, but those at producer plants declined 7% compared with 1971 figures.

PRICES

Published prices for high-quality molybdenum concentrate and primary products were unchanged from yearend 1971. However, because of an oversupply condition, some discounting was prevalent during 1972, particularly in the byproduct markets. A leading producer of byproduct molybdenum announced price reductions twice during the year on two grades of molybdic oxide. Byproduct concentrate sales were reportedly made at $1.45 to $1.60 per pound, and some Chilean material was sold at $1.40 per pound. Ferromolybdenum reportedly was discounted about 7 cents below the published price.

For the short range, future prices may not increase with inflation. On the other hand, reasonably stable prices are expected to favor increased consumption in industrial plants and equipment.

FOREIGN TRADE

U.S. exports of molybdenum in ore and concentrate, including roasted concentrate, declined for the fourth consecutive year (table 7). The Netherlands again was the principal recipient, receiving 42% of the total. Most of the material entering the Netherlands was reshipped to other European countries.

Despite a decline in exports, the United States continued to be a major supplier of molybdenum for the world. Foreign markets received 39% of the nation's output compared with 42% and 50% in 1971 and 1970, respectively. The U.S. share of the foreign market was expected to decline further because of the competition from excess production capacity in Canada and Chile.

Ferromolybdenum valued at $1.2 million was exported to 15 countries; Sweden and West Germany received 41% of total shipments. Exports declined for the second consecutive year.

Other molybdenum materials exported included metal, alloys in crude form, scrap, wire, powder, and semi-fabricated forms. Total value of this material was reported in excess of $2.9 million, or 4% over that exported in 1971. Although the nation is self-sufficient in molybdenum materials, some concentrate, molybdenum products, and chemicals enter the United States from numerous countries throughout the free world. High tariff rates preclude the importation of such material in large quantities. Import duties negotiated under the 1967 "Kennedy Round" of Tariff Negotiations effective January 1, 1973, are shown in table 9.

According to the U.S. Department of

Table 6.—Molybdenum reported by producers as shipments for export from the United States

(Thousand pounds contained molybdenum)

Product	1971	1972
Molybdenite concentrate	31,513	34,390
Molybdic oxide	12,292	14,577
All other primary products	1,718	1,541

Table 7.—U.S. exports of molybdenum ore and concentrate (including roasted concentrate), by country

(Thousand pounds contained molybdenum and thousand dollars)

Destination	1971		1972	
	Quantity	Value	Quantity	Value
Argentina	23	32	8	16
Australia	252	412	117	196
Austria	160	300	389	638
Belgium-Luxembourg	1,936	3,473	3,708	5,990
Brazil	147	263	359	612
Canada	1,353	2,372	386	714
Czechoslovakia	--	--	130	234
France	855	1,321	1,123	1,595
Germany:				
East	105	191	--	--
West	4,521	6,832	5,212	7,172
India	461	765	35	53
Italy	504	889	598	1,020
Japan	11,032	17,959	9,113	14,302
Mexico	531	596	405	569
Netherlands	20,777	37,750	19,207	32,743
New Zealand	3	6	28	41
Philippines	63	122	3	7
South Africa, Republic of	31	51	114	178
Spain	14	25	18	29
Sweden	1,649	2,515	2,013	3,245
United Kingdom	1,856	3,216	2,199	3,372
Venezuela	--	--	185	292
Other	11	21	12	21
Total	46,284	79,111	45,362	73,039

Table 8.—U.S. exports of molybdenum products

(Thousand pounds, gross weight, and thousand dollars)

Product and country	1971 Quantity	1971 Value	1972 Quantity	1972 Value
Ferromolybdenum:[1]				
Argentina	51	69	62	83
Australia	307	413	130	175
Brazil	16	24	40	58
Canada	183	253	74	149
Germany, West	--	--	186	183
India	201	370	11	16
Japan	452	651	81	64
Netherlands	18	23	7	9
Philippines	14	19	7	10
South Africa, Republic of	53	72	75	102
Sweden	44	61	220	290
Taiwan	6	8	--	--
Other	10	15	16	24
Total	1,355	1,978	909	1,163
Metal and alloys in crude form and scrap:				
Belgium-Luxembourg	2	13	3	9
France	1	7	4	17
Germany, West	15	36	3	16
India	(2)	1	--	--
Italy	(2)	2	--	--
Japan	23	37	23	39
Netherlands	81	27	--	--
South Africa, Republic of	--	--	8	51
Turkey	7	10	--	--
United Kingdom	93	93	45	58
Other	(2)	1	3	9
Total	222	227	89	199
Wire:				
Argentina	1	20	4	29
Australia	11	68	13	79
Austria	--	--	2	19
Brazil	11	119	18	198
Canada	27	205	30	322
Finland	--	--	1	11
France	20	127	32	214
Germany, West	21	148	14	108
India	6	54	1	5
Italy	1	8	5	32
Japan	22	124	32	195
Mexico	4	77	8	133
Netherlands	1	16	--	--
Philippines	1	18	1	26
Singapore	8	70	1	6
United Kingdom	4	132	11	150
Other	2	26	(2)	24
Total	140	1,212	173	1,551
Powder:				
Canada	2	8	3	12
France	3	13	2	16
Germany, West	1	6	5	16
Italy	(2)	1	1	4
Japan	4	23	(2)	1
Mexico	1	4	--	--
South Africa, Republic of	6	8	--	--
Sweden	19	74	30	114
Switzerland	3	10	9	21
United Kingdom	2	10	(2)	2
Other	(2)	13	(2)	6
Total	41	170	50	192
Semifabricated forms, n.e.c.:				
Australia	(2)	4	2	17
Belgium-Luxembourg	303	242	(2)	2
Canada	8	47	12	106
France	4	98	9	109
Germany, West	3	53	4	41
India	(2)	1	18	13
Ireland	1	5	--	--
Italy	1	20	6	30

See footnotes at end of table.

Table 8.—U.S. exports of molybdenum products—Continued

(Thousand pounds, gross weight, and thousand dollars)

Product and country	1971		1972	
	Quantity	Value	Quantity	Value
Semifabricated forms, n.e.c.—Continued				
Japan	1	17	4	51
Mexico	2	11	10	18
Netherlands	39	206	64	231
Philippines	2	4	--	--
South Africa, Republic of	(2)	4	29	185
Switzerland	(2)	6	(2)	4
Taiwan	1	14	2	13
United Kingdom	35	76	18	152
Venezuela	223	380	(2)	2
Other	(2)	7	3	13
Total	623	1,195	181	987

[1] Ferromolybdenum contains about 60% to 65% molybdenum.
[2] Less than ½ unit.

Table 9.—U.S. import duties

Item	Article	Rate of duty, Jan. 1, 1973 [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 Communist countries.
[2] Duty on waste and scrap temporarily suspended.

Commerce, imports for consumption of molybdenum materials included concentrate, waste and scrap, wrought metal, and chemical compounds. Total value of these products was reported at $1.6 million, or about 34% less than 1971 imports.

Molybdenum concentrate containing 384,811 pounds of molybdenum and valued at $543,564 was received from four countries, namely, Peru, Canada, Chile, and Mexico. Peru supplied nearly one-half of the imports. The molybdenum content of waste and scrap imported from five countries totaled 116,273 pounds valued at $223,518. West Germany, the Netherlands, and United Kingdom supplied 97% of the shipments. Imports of 23,447 pounds of molybdenum contained in wrought metal products were received from seven countries. Austria and the United Kingdom were the principal suppliers.

Molybdenum chemicals and related materials entering the United States included molybdenum compounds, inorganic compounds, molybdenum orange, and ammonium molybdate. Imports of molybdenum compounds totaling 1,758 pounds contained weight and valued at $11,109 were received from two countries. West Germany supplied most of the material. Four countries exported molybdenum orange to the United States. The gross weight of the material totaled over 1.3 million pounds valued at $484,173. Canada and Japan supplied about 65% of the total value. Inorganic compounds and ammonium molybdate were imported to the United States from two countries and totaled 24,130 pounds contained weight valued at $120,715.

Table 10.—Molybdenum: World mine production by country

(Thousand pounds contained molybdenum)

Country	1970	1971	1972 p
Australia	130	e 130	e 130
Canada (shipments)	33,772	22,663	24,844
Chile	r 12,569	13,935	13,045
China, Peoples Republic of e	3,300	3,300	3,300
Japan	r 582	613	825
Korea, Republic of (South)	254	231	110
Mexico	311	174	172
Norway	r 750	811	e 880
Peru	1,338	1,782	1,712
Philippines	71	9	--
U.S.S.R.e	17,000	17,600	18,100
United States	111,352	109,592	112,138
Total	r 181,429	170,840	175,256

e Estimate. p Preliminary. r Revised.

[1] In addition to the countries listed, Argentina, North Korea, Nigeria, Romania, South-West Africa, and Spain also may produce molybdenum, but information is inadequate to make reliable estimates of output levels.

WORLD REVIEW

Australia.—Minefield Exploration Ltd. continued geological investigation of its Mt. Mulgine molybdenum prospect in Western Australia. The company was spending $300,000 for exploration purposes and reportedly was no longer seeking a partnership arrangement in developing the property. In 1971, the company discovered a complex mineral deposit estimated at 118 million tons of ore containing molybdenum, copper, gold, silver, and bismuth.

Canada.—Molybdenum production increased about 2.2 million pounds in 1972 and was nearly 10% over that of 1971. About one-half of Canadian output came from byproduct plants. Canada consumes about 6% of its production; hence, as in the United States, Canada depends on export markets to maintain a viable molybdenum mining industry. Because of a continued worldwide oversupply of the material, some mines were closed, some curtailed production, and some byproduct plants did not recover molybdenum during the year. Molybdenum in stock at various plant sites was estimated in excess of 20 million pounds at yearend. Despite an oversupply situation and mounting inventories, new byproduct mining facilities came onstream and an active exploration program discovered new molybdenum prospects during the year.

A number of geological reports describing molybdenum deposits in Canada and the western Cordillera of North America were published.[3]

Endako Mines Ltd., owned by Placer Development Ltd., reduced molybdenum output from 14.4 million to about 9 million pounds annually during the first quarter 1972. It was the second cutback in production in less than a year; the firm dropped molybdenum output 25% in August 1971. The additional reduction was necessary because of mounting inventories due to depressed markets in Japan and Europe. The company's accumulation of unsold molybdenum in concentrate reportedly was nearly 8 million pounds at yearend. Approximately 75 employees of the total work force of 420 were terminated because of the production curtailment. During 1972, the mill treated nearly 6.4 million tons of ore at an average grade of 0.149% molybdenum disulfide. On the basis of operating days, the concentrator processed 24,150 tons per day. The metallurgical recovery was 81.2%. The roaster operated at maximum capacity throughout the year. Enlargement of the roasting capacity was contemplated in order to meet an increasing demand for molybdic oxide.

[3] Dagger, G. W. Genesis of the Mount Pleasant Tungsten-Molybdenum-Bismuth Deposit, New Brunswick, Canada. Inst. Min. Met., v. 81, No. 786, May 1972, pp. 73–102.

Clark, K. F. Stockwork Molybdenum Deposits in the Western Cordillera of North America. Econ. Geol., v. 67, No. 6, September–October 1972, pp. 731–758.

Ney, C. S., J. M. Anderson, and A. Panteleyev. Discovery, Geologic Setting and Style of Mineralization, Sam Goosly Deposit, British Columbia. Can. Min. and Met. Bull., v. 65, No. 723, July 1972, pp. 53–64.

British Columbia Molybdenum Ltd., subsidiary of Kennecott Copper Corp., ceased operations at its molybdenum mine and mill facility near Alice Arm, British Columbia. Company officials stated that high production costs and a weak molybdenum market was the cause for the shutdown. The mine commenced production at yearend 1967, but operations were plagued with mining problems and high costs. For the past 4 years of operations 1968–1971, the mine produced nearly 22 million pounds of molybdenum.

Molybdenite Corp. of Canada Ltd. finally closed the Lacorne mine and mill in September. The operation located in northwestern Quebec was financially assisted for the past year by the provincial government to arrest the economic impact in the area due to its closing. In early 1971, the mine was temporarily closed because of marketing problems for molybdenite concentrate.

Red Mountain Mines Ltd., near Rossland in south-central British Columbia, suspended operations early in the year.

Utah International Inc. reached full production capability early in the first quarter at its Island Copper mine near Port Hardy on Vancouver Island, British Columbia. The deposit contains reserves estimated at 280 million tons of copper-molybdenum ore averaging 0.52% copper, 0.014% molybdenite, and significant rhenium values. The concentrator was designed to process about 12 million tons of ore annually, yielding 230,000 tons of copper concentrate and 1,500 tons of molybdenite concentrate. The grinding circuit, consisting of six large autogenous mills, each 32 feet in diameter and 14 feet long, is the largest in the world. Each mill uses 7,000 connected horsepower and has a grinding capacity of 240 tons of ore per hour.

Gibraltar Mines Ltd., owned principally by Placer Development Ltd., commenced concentrator operation in March on ore stockpiled from the recently developed open pit copper-molybdenum mine. The facility, located near McLeese Lake in the Cariboo district of British Columbia, was designed to process about 11 million tons of ore annually from which 100 million pounds of copper and about 2.5 million pounds of molybdenum will be recovered. Total reserves contained at four open pit operations were reported at 358 million tons, having an average grade of 0.373% copper and 0.016% molybdenite. Capital expenditures for development of the mineral deposit was reported at $68 million, or about 10% below estimated costs. The operational staff at the mine and mill facility totaled 350 persons. At yearend, the company authorized expenditures of $4.8 million for purchasing additional ore production, haulage, and related equipment. Deliveries of the equipment will be made over a 3-year period to coincide with new pit development. The mining rate was revised to provide greater flexibility and efficiency in meeting the concentrator requirements. A report describing the unique operation was published.[4]

Lornex Mining Corp. Ltd., managed by Rio Algom Mines Ltd., commenced production at an open pit copper-molybdenum mining facility near Logan Lake, British Columbia. The concentrator was designed to process about 14 million tons of ore annually from which 110 million pounds of copper and about 2.5 million pounds of molybdenum will be recovered. First shipments of copper concentrate were made during the second quarter 1972 by way of truck to Ashcroft, thence, by railroad to Vancouver for transshipment to foreign markets. The company negotiated a 12-year sales contract consigning the copper concentrate output to Japanese smelters, and molybdenum production for 5 years was sold to Philipp Brothers Co., a metal dealer in New York. Capital expenditures for development of the copper-molybdenum deposit was reported at $138 million. Construction of the facility, largest open pit base metal mine in Canada, was completed in less than 2 years. A work force totaling 550 persons was employed at yearend. Operations of the Lornex Mining Corp. Ltd. were described.[5]

Gaspé Copper Mines Ltd., owned by Noranda Mines Ltd., was spending $108 million for expansion of mine, mill, and smelter capacity and construction of new sulfuric acid and leaching plants. Mine production of copper-molybdenum ore was expected to increase to nearly 34,000 tons per day; 30,000 tons will be supplied from the Copper Mountain open pit mine, and the remainder from Neddle Mountain un-

[4] Canadian Mining Journal. Cariboo's Gibraltar Achieves Production. V. 93, No. 6, June 1972, pp. 71–86.

[5] Western Miner. Lornex Mining Corp. Ltd. V. 45, No. 8, August 1972, pp. 35–53.

derground operation. The facility, located near Murdockville, Quebec, will have a production potential of about 2 million pounds of molybdenum annually. Ore reserves were reported totaling 25.3 million tons averaging 1.17% copper at the Neddle Mountain mine and 260 million tons averaging 0.42% combined sulfide and oxide at the Copper Mountain mine. The ores contain significant amounts of molybdenum.

A preliminary feasibility study of Bethlehem Copper Corp. Ltd. (Canada) for its J–A copper-molybdenum deposit was reported to favor an economically viable mining operation at a rate of 25,000 tons of ore per day. The mineral deposit, containing about 300 million tons of proven ore grading 0.45% copper with significant amounts of molybdenum, was situated in close proximity to the company's Huestis open pit mine in the Highland Valley District, British Columbia. The J–A mineralization was classified as a porphyry type copper deposit, similar to other British Columbia mineral deposits. Initial development projects costing $2.5 million were authorized for relocation of roads, power lines, and a natural gas line. The company was conducting detailed engineering studies in conjunction with various consultants. Some of these investigations include mine design, plant layout, tailings disposal, reclamation programs, waste disposal, and water supply.

Highmont Mining Corp. Ltd. continued with development of a copper-molybdenum deposit in the Highland Valley district of British Columbia. At yearend, the company was negotiating sales contracts for future production. A feasibility study idicated a favorable economic operation at a rate of 25,000 tons of ore per day over a 20-year period. Ore reserves were estimated at 145 million tons having an average grade of 0.27% copper and 0.045% molybdenite.

United Asbestos Corporation was conducting exploratory drilling on molybdenite mineralization in the Gabarous Bay area of Nova Scotia. Company officials stated that several drill holes have encountered significant molybdenum values to a depth of 80 feet. Exploratory drilling and an economic evaluation of the deposit was intensified at midyear. The mineral investigation was conducted under an option agreement with Louisbourg Mines Ltd., owner of the property.

Chemalloy Minerals Ltd. acquired a major interest in a promising molybdenite deposit near Jellcoe, northeastern Ontario. Assays of some drill samples were reported to range in grade from 0.07% to 1.12% molybdenite.

Chile.—Corporación del Cobre (CODELCO), the Chilean State Copper Corp., was constructing a plant to recover molybdenum, rhenium, and other precious metal from copper ores produced at the Rio Blanco mine. The facility was expected to cost about $2.6 million. Rio Blanco was developed by the Cerro Corp. and was nationalized in 1971 by the Chilean Government.

Empresa Nacional de Minera (ENAMI), a Chilean Government agency for mineral development, reported that exploration activity continued at the Los Pelambres mineral deposit near Coquimbo, Chile. To date, drilling has resulted in outlining ore reserves totaling 400 million tons containing 0.8% copper with significant amounts of gold, silver, and molybdenum. An access road was being built in preparation for developing the huge deposit.

Egypt, Arab Republic of.—A significant molybdenum prospect was discovered in southeastern Egypt, about 60 miles east of Aswan. Two exploration holes were drilled to a depth of about 250 feet, and assays for a 125-foot section reportedly averaged 0.5% to 0.6% molybdenite. The exploration project was sponsored by a United Nation Development Program (UNDP). Additional funds totaling $2.3 million were authorized to evaluate the deposit; UNDP provided $1.1 million, and Egypt, the remainder.

Greenland.—Greenland Exploration Management Inc. acquired a 3-year exploration concession covering 12,850 acres near Godthab, from the Government of Denmark. The company geologists were reported investigating an outcrop of skarn (metamorphic rock) containing molybdenum and other metallic minerals.

Iran.—A $400 million contract was awarded to Parsons–Jurden Corp., U.S.A. for development and/or construction of a mine, concentrator, and smelter complex near Kerman. The project is based on the Sar-Cheshmeh mineral deposit reportedly containing 393 million tons of ore averaging 1.2% copper with significant molybdenum values to justify its recovery. The mine was expected to produce at a rate of 42,000 tons of ore per day. Completion of the project was scheduled for 1977.

Japan.—The construction of a molybdenum roasting plant by Japan Molybdenum Co. was delayed because of foreign exchange conditions and a continued decline in molybdenum requirements that have adversely affected the supply of investment capital. Planned capacity of the plant was 55,000 pounds of technical-grade oxide daily. AMAX was expected to contribute one-third of the plant's cost of construction.

Taiyo Mining & Industrial Co., a producer of molybdenum products and ferroalloys, obtained an exclusive license to a hydrometallurgical process from Molycorp for production of molybdenum and rhenium compounds. The process is unique in that high-purity compounds are produced from low-grade molybdenum disulfide concentrate.

Mexico.—Asarco and Cía. Mexicana de Cobre S.A. were investigating a copper-molybdenum deposit near La Caridad containing reserves estimated at 600 million tons averaging 0.8% copper and 0.016% molybdenite. A mine processing 28 million tons of ore annually was contemplated.

Netherlands.—At yearend, AMAX commenced operation of an ammonium molybdate and purified molybdic oxide conversion plant at Rozenburg near Rotterdam. The facility employs a new AMAX process to produce a complete range of high-purity molybdenum and derivative products for use in petrochemical and metallurgical industries. The highly automated plant was designed and constructed by Tebodin, NV, a Dutch firm.

Panama.—Canadian Javelin Ltd. continued drilling on a vast copper-molybdenum mineralized deposit in the Cerro Colorado concession near Boquete. More than 90 drill holes totaling over 45,000 linear feet were completed, but the extent of the ore body was undetermined at yearend. Several drill holes bottomed out in copper-molybdenum mineralization at depths to about ½ mile. Data on ore reserves were incomplete, but the ore body was reportedly estimated to contain 2.2 billion tons at a grade of 0.8% copper with significant amounts of molybdenite. Current exploration drilling was concentrated on an enriched zone containing an estimated 65 million tons of ore with an average grade of ore of over 1% copper.

The Cerro Colorado deposit is situated 32 miles from the Pacific Ocean. The company started construction of a 24-mile road from the Inter-American Highway System that parallels the Pacific coast in the area. A report describing the deposit was published.[6]

A feasibility study was contracted to Wright Engineers Inc. of Vancouver. Company officials expect the study to recommend a mining operation on the order of 30,000 to 35,000 tons of ore per day. The concentrate would be delivered by pipeline to a newly constructed Pacific coast port from whence it would be shipped to foreign markets.

Peru.—Development of the Cuajone copper-molybdenum deposit and construction of ancillary facilities by Southern Peru Copper Corp. (SPCC) was continued during the year. Work projects completed were site preparation for a concentrator and company town, 19.6 million tons of overburden stripped, and 11,450 feet of railroad tunnel mined. Expenditures totaled $82.6 million to date, of which $37 million was obligated in 1972. Compañía Constructura Utah S.A., subsidiary of Fluor Corp., U.S.A., was awarded the contract to conduct engineering, construction, and management on the project. SPCC continued negotiating with an international consortium of banks for financial assistance in developing the Cuajone deposit.

The Cuajone mine was expected to produce at a rate of 30,000 tons of ore per day. Ore reserves were reported at 468 million tons of ore, having an average grade of 1% copper with significant values of molybdenum to justify recovery.

Empresa Minero del Peru (Mineroperu) signed an agreement with a group of five Japanese copper smelting corporations to spend $2 million on a feasibility study of the vast Michiquillay copper-molybdenum deposit in northern Peru. A favorable report would result in the formation of a consortium of multinational companies

[6] Lutjen, G. P. Canadian Javelin Eyes Production at Major Copper Find in Panama. Eng. and Min. J., v. 173, No. 12, December 1972, pp. 60–63.

that would provide the $250 million financing for development of the deposit. Asarco geologists discovered the deposit during the early 1960's, and the company reportedly spent $10 million over a 10-year period on exploration. Ore reserves were estimated at 570 million tons averaging 0.72% copper with sufficient molybdenum to justify recovery.

Turkey.—Etibank Ltd. was granted an exploration license to prospect for molybdenum in the Orhaneli district of Bursa. Exploration rights in the area were formerly held by Turk Molipten.

TECHNOLOGY

The effect of surface pretreatment and the role of hydrogen, hydroxyl, molybdate, and calcium ions on the flotation of molybdenite were investigated using a Hallimond tube, contact angle measurements, electrokinetics, and electrode potential measurements, and the results were described.[7] The experimental results were analyzed in terms of the Derjaguin model of wettability. The flotability of molybdenite was found to be strongly affected by surface oxidation primarily because of the effect of the oxidation on electrical and hydration phenomena.

A report describing operations of a hydrometallurgical plant in recovering molybdenum from mixed oxide and sulfide ores was published.[8] The feed material consisting of tailings from sulfide flotation was upgraded by cycloning and then leached in a sulfuric acid solution. Activated charcoal was added that absorbed the molybdenum. The charcoal was separated from the pulp and then ammoniated. The oxide molybdate was washed from the charcoal, and the liquid evaporated until all ammonium dimolybdate crystallized out. From a feed grade of only 0.12% to 0.14% molybdenum, a product containing 99.8% molybdenum trioxide was obtained.

An experimental study was made to evaluate the performance of column flotation versus conventional flotation on the recovery of molybdenite from a Newfoundland ore.[9] The investigation included a factorially designed series of tests to determine satisfactory operating conditions of the column. In the course of the experiment, the results of a few depressants also were evaluated. Results indicated greater selectivity in the column and reduced reagent consumption.

The microstructure, hardness, and superconducting transition temperature of high-purity molybdenum-ruthenium alloys were investigated.[10] Optical and electron microscopy permitted the morphology and crystallography to be analyzed. An intermetallic compound was precipitated from a supersaturated liquid having angular particles. The hardness of the alloy was determined and deformation studied. The intermetallic phase showed little evidence of plastic deformation, and only brittle fractures were observed. The phase had a superconducting transition temperature in the "as-cast" condition.

Auger electron spectroscopy was used to determine surface concentration of molybdenum in certain types of stainless steel, and the results were described.[11] It was observed that certain thermal treatments will concentrate impurities at a free surface. In some steel, sulfur was observed to concentrate at the surface at a temperature of 330° C. Surface concentration of 14% was observed in mill-finished steel containing 1.95% molybdenum and one other steel containing 0.45% molybdenum.

The high temperature creep behavior of polycrystalline molybdenum was investigated at 1,720° C, using constant stress in an ultrahigh vacuum environment.[12] The strain dependence of the dislocation sub-

[7] Chandler, S., and D. W. Fuerstenau. On the Natural Flotability of Molybdenite. Trans. Soc. Min. Eng., AIME, v. 252, No. 1, March 1972, pp. 62–69.

[8] Lane, J. W., F. N. Bender, and R. A. Ronzio. Recovery of Molybdenum From Oxidized Ores at Climax, Colorado. Trans. Soc. of Min. Engineers of AIME, v. 252, No. 1, March 1972, pp. 77–82.

[9] Mathieu, G. I. Comparison of Flotation Column With Conventional Flotation for Concentration of a Molybdenum Ore. Canadian Min. and Met. Bull., v. 65, No. 721, May 1972, pp. 41–45.

[10] Flewitt, P. E. J., and A. J. Tate. Some Structural and Physical Properties of "As Cast" Molybdenum-Ruthenium Alloys. J. Less-Common Metals, v. 27, No. 3, June 1972, pp. 339–352.

[11] Barnes, G. J., A. W. Aldog, and R. C. Jerner. Surface Concentration of Molybdenum in Type 316 and 304 Stainless Steel by Auger Electron Spectroscopy. J. Electro-chem. Sci. and Tech., v. 119, No. 6, June 1972, pp. 684–686.

[12] Ericksen, R. H., and G. J. Jones. Analysis of Primary Creep of Molybdenum at High Temperatures. Met. Trans., v. 3, No. 7, July 1972, pp. 1735–1741.

structure was studied using the etch pit technique and transmission electron microscopy. Subboundaries were formed in the transient area of the creep curve. Grain growth occurred during testing, and this phenomena was evaluated in terms of deviations from parabolic time law behavior.

The rate of solution of molybdenum in molten iron saturated with carbon was described.[13] A rotating cylindrical molybdenum specimen was placed in a stationary graphite crucible containing an iron-base melt. Weight changes were measured to determine the solution rate in temperatures ranging from 1,315° C to 1,425° C. Theoretical and experimental correlations also were compared with the solution rate coefficient. Molybdenum diffusion in the liquid phase was observed to be rate limiting. The solution of molybdenum rod specimens in carbon-saturated liquid iron was found to be controlled by diffusion of molybdenum in the iron-carbon melt and can be predicted by a boundary-layer model.

Steel compositions were designed for application in the powdered metal forging process on the basis of new hardenability data.[14] Thirty-three steel compositions were prepared by normal casting and forging techniques to provide bar stock for the Jominy hardenability test. The steels contained varying combinations of 0% to 0.8% manganese, 0% to 0.8% nickel, 0% to 0.75% copper, and 0% to 0.75% molybdenum. Molybdenum was found to be the most effective element in imparting hardenability to carbon steel.

Dislocation interstitial interactions in high-purity molybdenum were investigated by means of internal friction measurements, and the results were described.[15] In some grades of molybdenum, a maximum was observed in the amplitude-dependent damping. The damping maximum appeared after annealed samples were deformed at room temperature and was attributed to the motion of dislocations produced by deformation. A reduction in damping observed at temperatures above 100° C was due to the diffusion of interstitial nitrogen atoms to dislocation lines.

The impact properties of high-tensile-strength steels were evaluated in relation to the cooling rate and the austenite grain size.[16] It was determined that the optimum cooling rate for the impact transition temperature varied with the hardenability of the steel. Also, the optimum cooling rate shifted to a slower cooling rate as the austenitizing temperature was increased. An electron microscopic study revealed that the structure with superior impact properties was a duplex martensite-bainite structure. The results suggest that the role of bainite in the duplex structure was the partitioning of austenite grains prior to the martensite transformation.

Patents were granted for upgrading byproduct molybdenite flotation concentrate from low-grade copper porphyry ore,[17] for the production of molybdenum trioxide and sulfur as a byproduct from molybdenite concentrate,[18] for the hydrometallurgical recovery of molybdenum,[19] for purifying roasted molybdenite of iron, lead, and zinc,[20] for removal of copper and lead impurities from molybdenite,[21] for recovery of molybdenum and rhenium from a solution obtained by leaching roasted molybdenum ores,[22] and for purification of lead containing molybdic oxide.[23]

---

[13] Gundlack, R. B., and R. D. Pehlke. Rate of Molybdenum Solution in Carbon-Saturated Liquid Iron. Met. Trans., v. 3, No. 9, September 1972, pp. 2337–2342.

[14] Smith, Y. E., and R. Pathak. New Hardenability Data for Application in Low Alloy Ferrous Powder Forging. Progress in Powder Met., v. 28, No. 9, September 1972, pp. 25–40.

[15] Olsen, D. R., and S. H. Carpenter. Dislocation Damping in High-Purity Molybdenum. Met. Trans., v. 3, No. 12, December 1972 , pp. 3087–3092.

[16] Ohtani, H., F. Terasaki, and T. Kunitake. The Microstructure and Toughness of High Tensile Strength Steels. Trans. Iron and Steel Inst. Japan, v. 12, No. 2, December 1972, pp. 118–127.

[17] Castillo, C. O. (assigned to Kennecott Copper Corp.). Upgrading Molybdenum Concentrate From Copper Porphyry Ores. U.S. Pat. 3,645,455, Feb. 29, 1972.

[18] Barry, H. F., C. J. Hallada, and R. W. McConnell (assigned to American Metal Climax, Inc.). Liquid Phase Oxidation. U.S. Pat. 3,656,888, Apr. 18, 1972.

[19] Skarbo, R. R. (assigned to Kennecott Copper Corp.). Chemical Precipitation. U.S. Pat. 3,653,815, Apr. 4, 1972.

[20] Barry, H. F., C. J. Hallada, and J. D. Baker (assigned to American Metal Climax, Inc.). Alkaline Leaching. U.S. Pat. 3,658,464, Apr. 25, 1972.

[21] Stanley, R. W., H. L. Ames, and P. H. Jennings (assigned to Brenda Mines Ltd.). Beneficiation and Concentration. U.S. Pat. 3,674,424, July 4, 1972.

[22] Litz, J. E. (assigned to Continental Ore Corp.). Ion Exchange. U.S. Pat. 3,681,016, Aug. 1, 1972.

[23] Drobnick, J. L., and T. T. Chen (assigned to Molybdenum Corp. of America). Acid Leaching. U.S. Pat. 3,694,147, Sept. 26, 1972.

Natural Gas

By William B. Harper [1] and Leonard L. Fanelli [2]

Natural gas consumption in 1972 was only slightly above that of 1971. Pipeline transmission companies were compelled to curtail sales to industrial consumers. However, these curtailments were slightly more than offset by increases in residential and commercial uses. Total natural gas used in 1972 amounted to nearly 23 trillion cubic feet, or nearly 1.5% over that of 1971. Production totaled 22.5 trillion cubic feet in 1972, a volume only 38.7 billion cubic feet or 1% higher than that of 1971, as shown in table 1. Pipeline imports passed the 1 trillion-cubic-foot milestone in 1972, rising to 1,019 billion cubic feet, a 9.1% increase. Canada accounted for all but 1% of imports in 1972. In addition, 674,000 barrels of liquefied natural gas (LNG), equivalent to 2,261.5 million cubic feet (MMcf), were imported from Algeria and Canada.

Approximately 30 billion cubic feet of natural gas was exported by pipeline, of which 52% was moved to Canada by pipeline. Mexico received 14.6 billion cubic feet or 48% also by pipeline. In addition, 47.9 billion cubic feet of LNG was exported to Japan from Alaska during 1972.

Proved reserves of natural gas declined again as withdrawals (production) exceeded, by a wide margin, additions to reserves from new discoveries and extensions of known fields. Also, previous estimates of reserves were revised downward drastically, particularly in Texas.

The average value of natural gas at the well inched upward 0.4 cents from 18.2 cents to 18.6 cents per thousand cubic feet (Mcf).

Some 604,000 new residential users of natural gas were added, raising the total to 39,871,000 by the end of 1972, for an increase of 1.5%. The use of gas by residential clients increased 3.0%.

Pipeline networks expanded in 1972. Some 16,500 miles of line were added primarily in the distribution category. Capital expenditures for new plants and equipment rose from $2,419 million in 1971 to $2,822 million in 1972. Construction of new synthetic gas plants using liquid hydrocarbons, such as naphtha for feedstocks, are progressing slowly. One such plant, designed to operate seasonally, has been completed, and two similar plants are expected to start up early in 1974. At the end of 1972, there were three plants under construction.

Coal gasification received additional impetus as the result of an agreement between the Department of the Interior and the American Gas Association (AGA) to jointly finance a research program that will cost about $120 million over a 4-year period. This project is being funded through the Department of the Interior's Office of Coal Research.

Inability to obtain additional gas supplies has created problems for both the transmission companies and the distributors. Firm volume curtailments for the 1972–73 winter season, reported by 14 pipeline transmission companies, totaled 565.6 billion cubic feet according to the Federal Power Commission (FPC).

Legislation and Government Programs.—Federal Power Commission (FPC) Area Rate Proceedings:

South Louisiana Area.—Subsequent to the issuance by the FPC of Opinion 598 establishing base area rates in the South Louisiana Area, the Commission issued another opinion, Opinion 598-A, on rehearing in September 1972. Arguments were heard in October 1972, and since then the Fifth Circuit Court has affirmed FPC Opinion 598 which accepted the United Distribution Companies (UDC) Settlement Proposal in the second South Louisiana Area

[1] Mineral specialist, Division of Fossil Fuels.
[2] Survey statistician, Division of Fossil Fuels.

Rate Proceeding (AR 61–2 et al, AR 69–1).[3]

Other Southwest Area.—The FPC Opinion 607 determined rates in the area[4] ranging from 19.4 cents to 20.6 cents per Mcf for gas produced under contracts dated before October 1, 1968. For production under contracts dated after October 1, 1968, rates ranged from 22.5 cents to 26.0 cents. In January 1972, the FPC issued an opinion on rehearing (No. 607-A) which included a proviso giving natural gas producers the option of meeting their refund responsibilities by the dedication of new reserves to interstate commerce. This opinion was sent on appeal to the U.S. Court of the Fifth Circuit and the Court upheld the FPC decision in Opinion 607, establishing rates for pre—1961 contracts, 1961–68 contracts, and post—October 1, 1968, "new" gas contracts. Base area rates for the three different vintages are as follows:

	Cents per thousand cubic feet (Mcf) [1]						
	First vintage gas deliveries			Second vintage gas deliveries			Third vintage gas deliveries
	Contracts dated before Jan. 1, 1961			Contracts dated Jan. 1, 1961–Sept. 30, 1968			
	Prior to Jan. 1, 1965	Jan. 1, 1965 to Sept. 30, 1968	From Oct. 1, 1968	Prior to Jan. 1, 1965	Jan. 1, 1965 to Sept. 30, 1968	From Oct. 1, 1968	Contracts dated after Oct. 1, 1968
Other Oklahoma	17.5	18.4	19.4	18.4	18.9	19.4	23.75
Texas District 9	17.8	18.7	19.7	18.7	19.2	19.7	24.0
Northern Arkansas	17.0	17.9	18.8	17.8	18.3	18.8	23.0
Texas District 5	(2)	(2)	(2)	(2)	(2)	(2)	23.5
Texas District 6	15.0	17.0	19.1	18.1	18.6	19.1	23.5
North Louisiana	16.7	18.6	20.6	19.6	20.1	20.6	25.0
Southern Arkansas	14.4	16.25	18.25	17.25	17.25	18.25	22.5
Mississippi-Alabama	19.0	19.5	20.0	19.0	19.5	20.0	25.0
Mississippi offshore (Federal Domain)	(3)	(3)	(3)	(3)	(3)	(3)	26.0

[1] Prices stated at 15.025 psia in North Louisiana, Mississippi, and Alabama, and at 14.65 psia in all other areas.
[2] No jurisdictional contracts dated prior to Oct. 1, 1968.
[3] No production to date from offshore Mississippi.

In addition, FPC Opinion 607 provided for the following: (1) A 1 cent escalation in rates for all vintages of gas effective October 1, 1973 (October 1, 1974, in the case of offshore Mississippi); (2) except for these fixed escalations, a moratorium to July 1, 1976, on further price increases; (3) deductions ranging from 1.0 cents to 1.5 cents, depending on subarea, for ungathered gas; (4) quality standards and price adjustments for quality; and (5) refund of all amounts collected subject to refund in excess of the applicable area rates.

Subsequently, in Opinion 607-A, the FPC authorized a refund workoff procedure similar to that established by its decisions in the South Louisiana and Texas Gulf Coast Area cases. Specifically, the FPC provided that producers could apply a credit of 1 cent for each Mcf of new gas reserves in the Other Southwest Area dedicated to interstate pipelines from the date of the instant order through January 1, 1976.

Appalachian and Illinois Basin Areas.—Four natural gas companies operating in the Northeastern United States filed a petition in January 1972, asking that ceiling rates for gas purchases from the Appalachian Basin be increased to at least 50 cents per Mcf. Faced with a severe shortage of natural gas, the four companies asserted that the requested increase would stimulate exploration and development and would result in new reserves for the northeast market area.

Permian Basin Area (AR70–1 Permian II).—This proceeding was initiated on July 17, 1970, at the same time as the FPC's R-389 rulemaking proceeding to establish new ceiling rates for the certification of new contracts in the Permian Basin Area. In December 1972 an FPC judge recommended a 35-cent ceiling on

[3] FPC Opinion 598 and the UDC Settlement Proposal are discussed in detail in the Natural Gas chapters of the Bureau of Mines Minerals Yearbook 1970 and 1971 editions.

[4] Includes Mississippi; Arkansas; four counties in northwest Alabama; northern Louisiana; Texas Railroad Commission Districts 5, 6 and 9; and 56 counties in eastern and southeastern Oklahoma.

Table 1.—Salient statistics of natural gas in the United States

	1968	1969	1970	1971	1972
Supply:					
Marketed production [1] million cubic feet	19,322,400	20,698,240	21,920,642	22,493,012	22,531,698
Withdrawn from storage do	1,329,536	1,379,488	1,458,607	1,507,630	1,757,218
Imports do	651,885	726,951	820,780	934,548	1,019,496
Total do	21,303,821	22,804,679	24,200,029	24,935,190	25,308,412
Disposition:					
Consumption do	19,459,939	20,922,800	22,045,799	22,676,581	23,009,445
Exports do	93,745	51,304	69,813	80,212	78,013
Stored do	1,425,075	1,498,988	1,856,767	1,839,398	1,892,952
Lost in transmission, etc do	325,062	331,587	227,650	338,999	328,002
Total do	21,303,821	22,804,679	24,200,029	24,935,190	25,308,412
Value at wellhead:					
Total thousand dollars	3,168,688	3,455,615	3,745,680	r 4,085,482	4,185,869
Average cents per thousand cubic feet	16.4	16.7	17.1	18.2	18.6

r Revised.
[1] Marketed production of natural gas represents gross withdrawals less gas used for repressuring and quantities vented and flared.

base area rates for sales under contracts dated October 1, 1968 and later, and 19.5 cents per Mcf for sales dated prior to October 1, 1968. Subsequently, the FPC issued Opinion 662 substantially adopting the initial decision (issued December 20, 1972) by FPC Judge Nahum Litt in the second Permian Basin Area Rate Proceeding (AR70–1). The Commission approved his recommendation of a base area rate of 35 cents per Mcf for sales under contracts dated October 1, 1968, and later, but granted a flowing gas rate of 23 cents per Mcf, which includes an additional 3.5 cents per Mcf above the 19.5-cent rate recommended by the FPC judge for exploration and development, for sales under contracts dated prior to October 1, 1968. In addition, the Commission agreed with the FPC judge's approval of fixed escalations of 1 cent in base ceiling rates, on October 1, 1974, for pre-October 1, 1968, contracts and on October 1, 1975 for post-October 1, 1968 contracts.

Other recommendations of FPC Judge Litt approved by the Commission include the following: (1) Contingent escalations in rates under pre-October 1, 1968, contracts upon dedication of specified quantities of additional Permian Basin reserves to interstate commerce over the next 5 years, 0.5 cent for commitment of 4 trillion cubic feet, a further 0.5 cent for a total of 8 trillion cubic feet, and another 1.0 cent for a total of 12 trillion cubic feet; (2) a refund credit procedure enabling producers to discharge their refund obligations through dedication of additional gas reserves in the Permian area to interstate buyers (at the rate of 1.0 cent for each Mcf dedicated) over the 5-year period to January 1, 1978; (3) application of base area rates according to the date of discovery, rather than contract date, for production from newly discovered reservoirs on previously committed acreage; and (4) continuation of the quality standards and adjustments (except involving the British thermal unit (Btu) adjustment noted below) imposed in the first Permian case.

Opinion 662, however, modified the FPC judge's decision in the following respects: (1) It eliminated the 5-year moratorium on above-ceiling rate increases; (2) it increased from 1.0 cent to 1.5 cents the allowance for substantial offlease gathering (but eliminated a 0.5-cent increase on January 1, 1978; (3) it increased the minimum rate from 12.0 cents to 15.0 cents per Mcf; (4) it eliminated the Btu adjustment gap of 1,000 to 1,050 Btu; and (5) it provided for an adjustment to reflect 87.5%, rather than 75%, of any change in State or Federal production, severance, gathering, or similar taxes.

Sales, Small Producers.—Producers selling less than 10 billion cubic feet of natural gas annually and not affiliated with pipelines were relieved of complying with producer rates and certificate regulations by FPC Order 428, issued March 18, 1971. On December 12, 1972, however, the U.S. Court of Appeals for the District of Columbia circuit, reversed FPC Order 428, holding that the Order exceeded the FPC's authority under the Natural Gas Act.

Small producers account for about 15% of the interstate gas sales and comprise an important source of nonassociated gas discoveries even though production activities are relatively small.

Pipeline Safety.—Based on failure reports from which table 2 was developed, the Office of Pipeline Safety (OPS) estimated that 70% of the gas distribution incidents and 50% of the transmission line failures during the last 3 years, resulted from outside force damage. In January 1972, OPS sent to key officials of State and local governments and others concerned with damage problems, a proposed model statute to be enacted in order to reduce damage to buried pipelines and utilities which can result during underground construction work. Five amendments to the Federal safety standard, established under the Natural Gas Pipeline Safety Act of 1968, were issued in 1972.

One amendment extended the effectivity of interim Federal safety standards applicable to gas odorization in States requiring odorization in transmission lines.

Several serious gas explosion incidents, resulting from the unauthorized introduction of natural gas into inactive gas service lines, demonstrated a clear need for more stringent requirements to prevent such occurrences. An amendment was added to prevent unauthorized persons from activating gas service lines that have been deactivated, abandoned, or not presently in use.

An amendment, which modified the restrictions on accidental pressure buildup in certain pipelines other than low-pressure distribution systems, was issued. This amendment should provide more realistic pressure relief limitations.

Aware of the rapid growth in construction and operation of facilities to transport and store liquefied natural gas (LNG), the OPS in the Department of Transportation issued an amendment adding a new section to the Federal Safety Standards applicable to those gas pipeline facilities used to store, treat, or transfer LNG.

Another amendment was issued on October 11, 1972, which allows permanent field repair of pipeline leaks on certain lower pressure transmission lines.

DOMESTIC PRODUCTION

Gross production of natural gas represents the total amount of gas produced, including marketed production of gas, gas returned to the formation for pressure maintenance, and the gas vented or flared. In 1972, gross production aggregated nearly 24.0 trillion cubic feet or slightly below the almost 24.1 trillion cubic feet produced in 1971.

A 4% decline in the gross production of gas from oil wells, from 5.2 trillion to 4.9 trillion cubic feet, more than offset an increase of 117 billion cubic feet of gas withdrawn from gas wells. Increased gross production was noticeable primarily in five States. In New Mexico, Oklahoma, and Texas withdrawals of natural gas were moderately higher. Significant gains, however, were made in the smaller gas producing States of Alabama and Florida. Availability and the startup of new natural gas processing plants in which sulfur recovery units are incorporated, were the prime causes for these production increases. Much of the natural gas in this region has a high sulfur content. Higher prices for gas, however, provided an incentive to extract the sulfur so that the gas would be acceptable for pipeline transmission. The sulfur extracted from the gas is sold to fertilizer manufacturers.

On the negative side, there were very sizable reductions in the gross withdrawals of gas in California and in Louisiana. In both instances the reductions were in the volume of associated gas withdrawn from oil wells as shown in table 3. Gas well gas withdrawals in Louisiana also decreased 87.5 billion cubic feet in 1972.

Marketed production in 1972, however, was 38.7 billion cubic feet above that of 1971, because less gas was vented and flared and less gas was used for repressuring than in 1971. In Texas, a reduction of 64.9 billion cubic feet used for repressuring made that much more gas available for market. A reduction in Louisiana of nearly 40 billion cubic feet in the volumes of gas vented or flared however was not large enough to offset the overall decline in marketed production. Marketed production in 1972 was 109 billion cubic feet lower in 1972 in Louisiana. Year to year changes are shown in table 3.

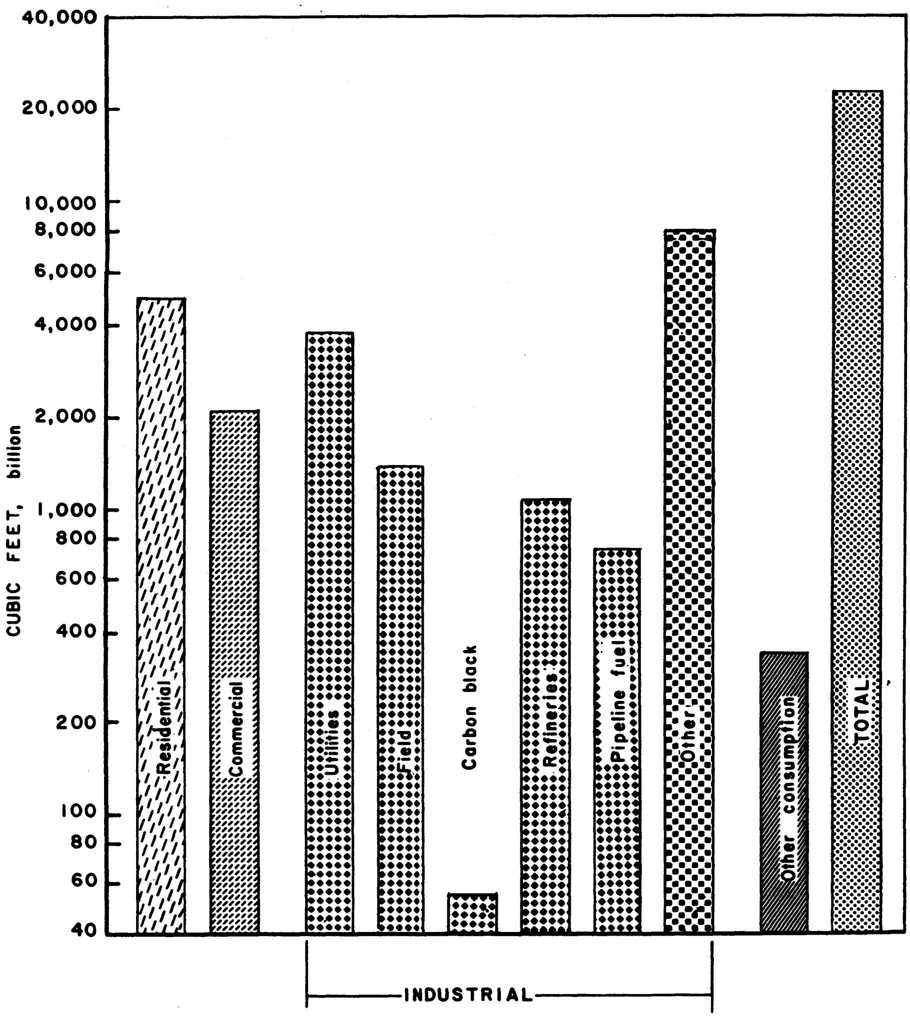

Figure 1.—Disposition of natural gas consumed in the United States by principle use.

Rising prices for naural gas and the endorsement of FPC Opinions by the Courts, relative to FPC Area Rate Proceedings, were beginning to encourage investment in gas exploration and production. During 1972, there were 4,928 gas wells drilled compared with 3,830 gas wells in 1971 or a gain of 28.7% as shown in table 4. There were, in 1972, 601 exploratory gas wells drilled as compared with 437 wells in 1971, a gain of 37.5%, and the drilling pace accelerated in 1973. A 6-year tabulation of gas and combination oil and gas well completions for gas is presented in table 5.

Higher prices for natural gas have made it economical to build natural gas processing plants with sulfur recovery units. As a result, efforts are being made to drill and explore for gas whether it be sweet or sour. This effort is noticeable in States where production has been small, such as in Alabama. Production in that State in 1972 increased tenfold; proved reserves increased from 180,508 million cubic feet

(MMcf) as of December 31, 1971, to 245,714 MMcf as of December 31, 1972, an increase of 36.1%.

Oil well completions are included insofar as they include multiple completion wells which may produce gas from one or more zones but oil from at least one zone as well. In 1972 there were 729 multiple completion wells completed and producing from 1,501 zones. Of this total, there were 799 zones classified as oil and 702 as gas. In the combination oil- and gas-well category, 120 wells were producing from 124 oil zones and 124 gas zones. Also in 1972, there were 278 multiple completion gas wells producing from 578 zones.

Gas wells also include condensate wells producing from high-pressure natural gas reservoirs. Some of these reservoirs produce considerable quantities of liquid hydrocarbons such as pentanes and heavier, described generically as "condensate."

Significant increases in gas well completions in 1972 were widespread. Reduced activity occurred in only three States: Colorado, Tennessee, and West Virginia.

It is interesting to note, however, that the accelerated pace of gas well drilling activity is taking place primarily onshore. Offshore gas well exploratory drilling in 1972 was far below activity in 1971. Offshore development well drilling did not exceed the levels of 1971 until the final quarter of 1972.

CONSUMPTION AND USES

Consumption of natural gas in 1972 totaled 23,009,445 MMcf, an increase of 1.5% over 1971, as shown in table 6. Gas delivered to consumers aggregated 19,879,733 MMcf, a 1.2% increase above the comparable total of 19,637,212 MMcf in 1971. Residential use in 1972 rose 3.1%, to 5,125,982 MMcf as shown in table 11. The residential consumption of natural gas ranks second to industrial use, and expansion in the use of gas for househeating is the prime reason for residential use, ranking second in size only to the industrial category. Over the past decade, the number of househeating customers grew from 23.6 million to 32.9 million or at an annual growth rate of 3.4%. Between 1971 and 1972 growth contracted to 2.7%. Trends in the number of househeating accounts by Census Regions for the years 1962, 1971, and 1972 are indicated in the following tabulation:

Census regions	Gas househeating customers (Thousands)		
	1962	1971 [r]	1972
New England	490	785	817
Middle Atlantic	2,804	3,801	3,897
East North Central	5,273	7,837	8,056
West North Central	2,253	3,033	3,090
South Atlantic	1,813	2,800	2,889
East South Central	1,324	1,779	1,813
West South Central	3,684	4,374	4,444
Mountain	1,253	1,783	1,889
Pacific	4,701	5,902	6,068
Total	23,595	32,094	32,963

[r] Revised.

Source: American Gas Association.

By far the largest segment in the consumer-use category is the industrial group. About 14% is consumed by industry. Industrial uses in 1972 accounted for 8,167 billion cubic feet, an almost imperceptible increase, percentagewise, above 1971. Most of the gas used by industry is consumed as fuel and more than 1 trillion cubic feet was used as refinery fuel as indicated in the footnote in table 11.

Natural gas is also an important petrochemical feedstock. About two-thirds of the use of gas as a feedstock occurs in the manufacture of ammonia, primarily for fertilizer. Most of the ammonia produced in the United States is obtained by reforming natural gas to produce the hydrogen-nitrogen mix required for ammonia synthesis. It is estimated that, on the average, the natural gas consumed per ton of ammonia was about 37 Mcf. This would mean that more than 435 billion cubic feet of natural gas was used to produce 11.7 million tons of synthetic ammonia in 1972. Methanol production is another important consumer of natural gas. There were nearly 3,000,000 short tons of methanol produced in 1972. Using 36 Mcf per short ton as a yardstick, it is estimated that 108 billion cubic feet of natural gas was consumed in methanol production. Carbon black production accounted for another 54 billion cubic feet. It is estimated that the chemical industry consumed nearly 900 billion cubic feet of natural gas or 11% of the total industrial use, as shown in table 11.

The uptrend in the consumption of natural gas by the electric utilities was reversed in 1972 when use was down slightly (to 14,310 Mcf) as increases in the west, southwest, and west coast States were not large enough to offset declines in the midwestern and eastern States.

There was only a slight increase in the number of commercial consumers in 1972—from 3,341,000 to 3,357,000 consumers, or less than 0.5%. Use of gas in this category, however, increased to 2,286,561 MMcf from 2,172,699 MMcf, or 5.2%.

In addition to gas delivered to consumers, there are three categories of gas-use separately classified in table 6: lease and plant fuel, pipeline fuel, and extraction losses. Gas used as lease and plant fuel (oil and gas field use) increased nearly 3%. Likewise, gas used as pipeline fuel increased 3%. The loss of gas in gas processing plants (shrinkage) increased 2.8% in 1972 as shown in table 7. In 1972, these plants processed 19,947,740 MMcf of natural gas (88.5% of marketed production), an increase of 3.6% over the 19,252,807 MMcf processed in 1971.

Although there has been a marked growth in natural gas use ever since long-distance natural gas transmission lines became a reality, the tight supply situation is becoming more and more critical for pipeline transmission companies. In fact, the shortage of gas forced major interstate gas pipeline companies to curtail gas service. During the April-October 1972 season, 11 of the 32 major pipelines listed in table 8, reported firm volume curtailments aggregating almost 555.4 billion cubic feet or 10.5% of their firm requirements of nearly 5.3 trillion cubic feet of natural gas. These curtailments were 64% greater than for the comparable season a year earlier. Table 8 is based on data submitted to the FPC.

The FPC has also drafted a series of proposed priorities of deliveries based on end use in Orders No. 467 A and 467 B. A list of these priorities follows:

1. Residential, small commercial (less than 50 Mcf on a peak day).

2. Large commercial requirements (50 Mcf or more on a peak day), firm industrial requirements for plant protection, feedstock and process needs, and pipeline customer storage injection requirements.

3. All industrial requirements not specified in 2, 4, 5, 6, 7, 8, or 9.

4. Firm industrial requirements for boiler fuel use at less than 3,000 Mcf per day, but more than 1,500 Mcf per day, where alternate fuel capabilities can meet such requirements.

5. Firm industrial requirements for large volume (3,000 Mcf or more per day) boiler fuel use, where alternate fuel capabilities can meet such requirements.

6. Interruptible requirements of more than 300 Mcf per day, but less than 1,500 Mcf per day, where alternate fuel capabilities can meet such requirements.

7. Interruptible requirements of intermediate volumes (from 1,500 Mcf per day through 3,000 Mcf per day), where alternate fuel capabilities can meet such requirements.

8. Interruptible requirements of more than 3,000 Mcf per day, but less than 10,000 Mcf per day, where alternate fuel capabilities can meet such requirements.

9. Interruptible requirements of more than 10,000 Mcf per day, where alternate fuel capabilities can meet such requirements.

Relative to the question of FPC jurisdiction on curtailments, a decision by the U.S. Supreme Court on June 7, 1972, held the FPC has jurisdiction over curtailments in the service of gas in interstate commerce to both resale and direct industrial customers.[5] This decision reversed a Fifth Circuit Court ruling that immunized direct industrial customers from curtailments.

The gas-distributing utilities are taking similar steps in establishing priorities. First, new industrial and commercial accounts were curtailed. Some utilities will no longer accept any new or additional customers capable of using in excess of 10 therms per hour. An average residential househeating customer can use approximately 2 therms per hour. A therm is a unit of heating value equivalent to 100,000 Btus.

The uncertainties as to the availability of new gas supplies is also having an impact on expansion of the pipeline networks. The mileage of natural gas pipelines increased to 951,200 miles in 1972 but the rate of growth moderated with the

[5] The U.S. Supreme Court in *FPC vs. Louisiana Power and Light Co.* 406 U.S. 621.

drying up of new gas supplies, as indicated in the following tabulation:

	1961	1971	1972
Field and gathering	56.7	66.5	67.1
Transmission	191.9	256.9	260.2
Distribution	410.4	611.3	623.9
Total	659.0	934.7	951.2

Some 16,500 miles were added in 1972 and distribution lines accounted for 12,600 miles of the total. Interstate movements of natural gas are shown in table 9. New interstate pipeline movements are available in table 10.

RESERVES

Production of natural gas has exceeded discoveries of new gas during 4 of the last 5 years and 1972 proved to be no exception. During 1972, production again exceeded discoveries by a wide margin and proved reserves of natural gas dropped from 278.8 trillion cubic feet at yearend 1971 to 266.1 trillion cubic feet by 1972 yearend, or a decline of 4.6%, according to the Natural Gas Reserves Committee of AGA.

Additions to reserves reported for the United States in 1972 aggregated nearly 10.8 trillion cubic feet. The largest segment, some 6.1 trillion, was derived from extensions to known fields. Second in importance was the 3.1 trillion cubic feet from new reservoir discoveries in old fields.

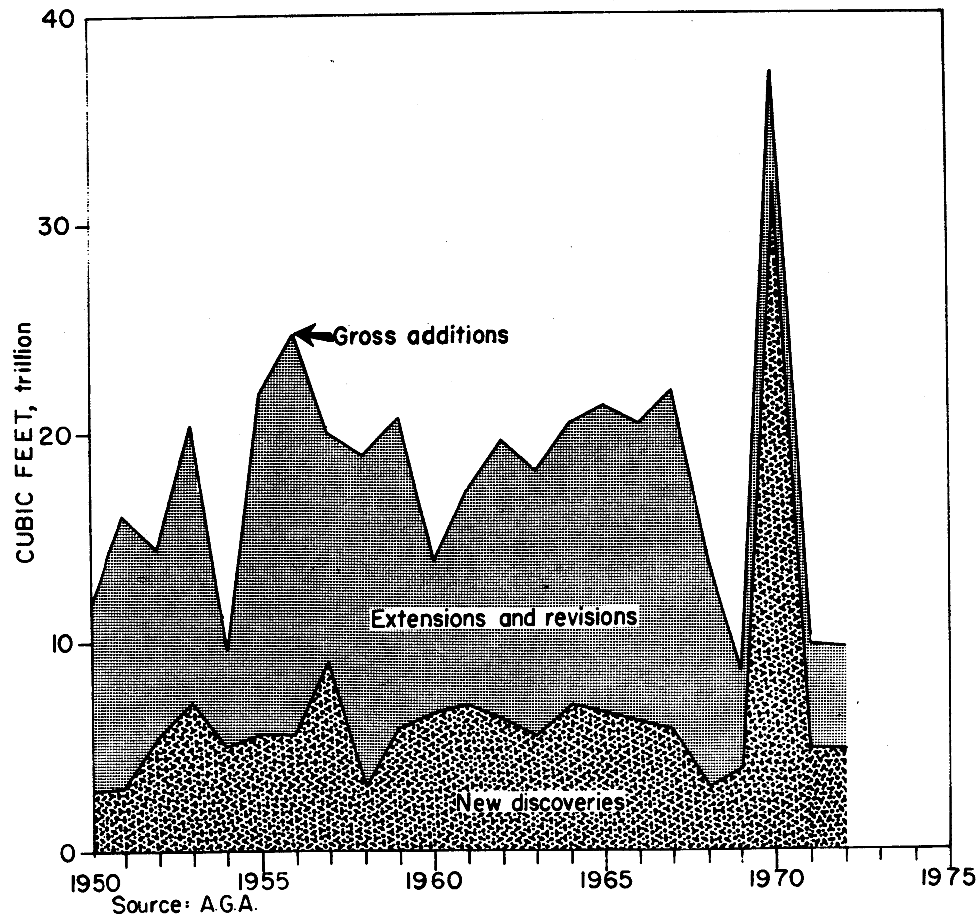

Figure 2.—Trends in annual gross additions to natural gas reserves.

More than two-thirds of the 3 trillion cubic feet came from Louisiana. In addition, discoveries of new fields totaled almost 1.5 trillion cubic feet of reserves. On the negative side, however, previous estimates of reserves in some States were revised. On balance, there was a reduction for the United States, as a whole, of nearly 1.1 trillion cubic feet as shown in table 12.

There were some increases in the reserves of natural gas in Alabama, Alaska, Illinois, Montana, Ohio, Pennsylvania, Utah, and other States which produce small amounts of gas. These net increases, however, aggregated only 688 billion cubic feet. On the negative side, reserves of major gas-producing States declined sharply. Texas gas reserves dropped from 101.5 trillion cubic feet to 95.0 trillion cubic feet, a decline of 6.4 trillion cubic feet. Likewise, in Louisiana proved reserves decreased 3.7 trillion cubic feet or 4.6% to 74.9 trillion cubic feet. Comparisons of the proved reserves as of December 31 for 1971 and 1972 are presented in table 12.

Estimated potential supply of natural gas in the United States as of December 31, 1972
(Trillion cubic feet at 14.73 psia and 60° F.)

	Probable	Possible	Speculative	Total
Report Dec. 31, 1972	266	384	496	1,146
Report Dec. 31, 1970	257	387	534	1,178
Change in report	+9	—3	+38	—32

The Potential Gas Committee (PGC) reports natural gas resources in three categories: probable, possible, and speculative. Briefly, "probable" refers to the unproved portions of existing fields; "possible" is production that will result from new field discoveries in areas of established production; and "speculative" is commercial natural gas that will result from new field discoveries in areas where sediments are present but have no prior production history. The PGC's estimate of the potential supply of natural gas in the United States, excluding the State of Hawaii, the island territories of the United States, and their adjacent offshore areas, is shown in table 13.[6]

Table 13 shows PGC's reserves estimates by hole depths and water depths for the United States.

In addition to exploration for new resources in the United States, American companies are involved, either independently or with Canadian companies, in exploring and drilling for oil and gas in Canada's Arctic Islands, the Maritime Provinces, and in the Mackenzie Delta. By the end of 1972, the delta had yielded seven bas-condensate and oil discoveries and established an impressive natural gas reserve base for Canada. These developments, plus significant natural gas discoveries in the Arctic Islands could possibly influence the National Energy Board of Canada to raise prevailing ceilings on exports of natural gas to the United States.

PRODUCTIVE CAPACITY

The daily productive capacity for natural gas at the end of 1972 was estimated to be 85,998 MMcf according to the AGA. This compares with 94,017 MMcf per day as of December 31, 1971. Productive capacity in nonassociated gas fell to 69,144 MMcf from 75,371 MMcf. Likewise, capacity in associated-dissolved gas was reduced to 16,854 MMcf from 18,646 MMcf per day as of December 31, 1971.[7] Compared with that of 1972, daily productive capacity had dropped 8 billion cubic feet or almost 8.5% by the end of 1972 as shown in table 14.

[6] The work by the PGC is supported by three industry associations: the AGA, the Independent Natural Gas Association of America (INGAA), and the American Petroleum Institute (API).

[7] The productive capacity of natural gas from nonassociated reservoirs is defined as the maximum daily rate at which such gas can be produced from natural reservoirs under specified conditions on March 31 of any given year. The determination of productive capacity on March 31 of any given year is based on proved reserves of nonassociated gas reservoirs as of the preceding December 31. The productive capacity of associated-dissolved gas is based on the productive capacity of crude oil and the estimated producing gas-oil ratios which would result from such capacity operation during the first 90 days of a given year. The productive capacity of associated gas from gas wells is usually based on the volumetric withdrawal of crude oil from related oil wells at capacity rates during the first 90 days of a given year as determined by the American Petroleum Institute (API) Committee on Reserves and Productive Capacity.

STORAGE

The development of additional underground storage capacity for natural gas, after slackening in 1970, moved at a faster pace in 1971 and 1972. Total reservoir capacity increased 8.3% from 5,575 MMcf in 1971 to nearly 6,040 MMcf by yearend 1972. The number of underground storage facilities expanded from 333 in 1971 to 348 in 1972. These storage facilities are located in 26 States.

Originally most of these reservoirs were depleted fields which contained dry gas. Of the 348 reservoirs, for example, 275 or 79% were the dry-gas type and, as evidenced in table 15, most of these dry-gas reservoirs are located in the northeastern United States, primarily in the oldest oil provinces. The second largest concentration is found in the midwest. In Pennsylvania, where oil production dates back to 1859, some 68 dry-gasfields have been converted to storage facilities. West Virginia added two more in 1972 and now has 33 dry-gas reservoirs. In Michigan, where oil production began on a small scale in the early 1900's, there were 30 of the dry-gas-type reservoirs as of the end of 1972.

In terms of capacity there was a net increase of 464,414 MMcf of which Illinois accounted for nearly one-quarter. Even more significant, however, is the increase in Mississippi. In 1971, there were three reservoirs in that State with 10,238 MMcf of capacity. During 1972 capacity was expanded to 108,956 MMcf and gas in storage increased sevenfold as shown in table 15.

In addition to storage underground there is a marked growth in the storage aboveground of natural gas liquefied by lowering temperatures. When natural gas is converted to a liquid by reducing its temperature to −258° F (−161° C) it occupies only 1/620th the space necessary for conventional vapor storage.

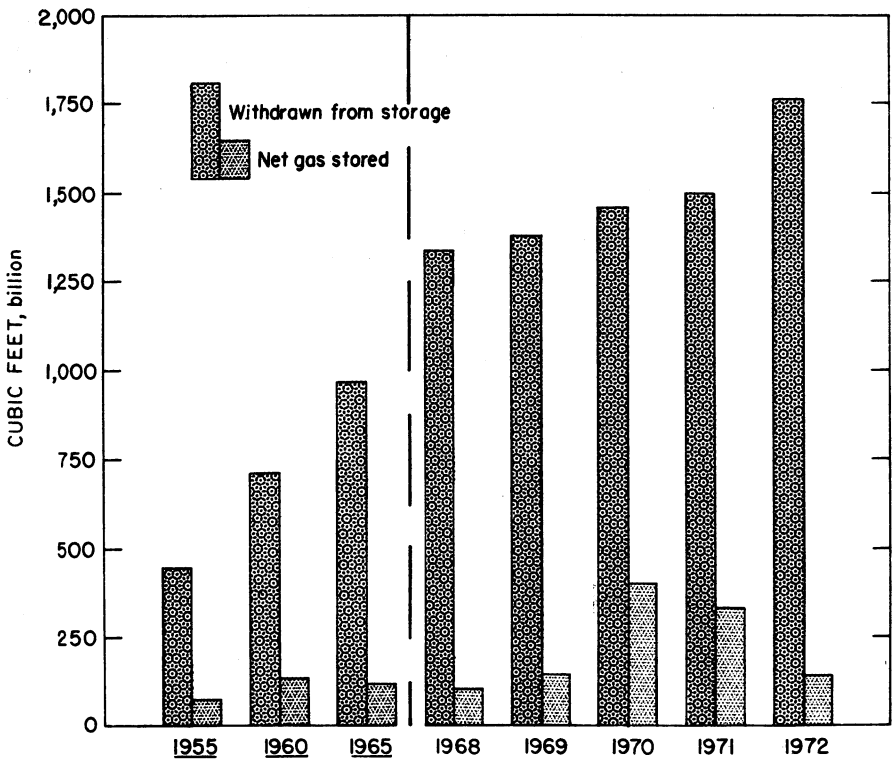

Figure 3.—Trends in net gas stored underground in U.S. storage fields.

There were, as of June 30, 1972, 22 LNG facilities for peak shaving purposes in operation and these had storage capacity aggregating 25,947 MMcf. Also, the 22 plants had a liquefaction capacity of 206 MMcf per day, In addition there were 17 plants, either proposed or pending operation, with storage capacity of 18,900 MMcf and a gross liquefaction capacity estimated at 95 MMcf per day.

For peak shaving purposes, relatively small quantities of gas are stored for use during the high-consuming, low-temperature winter months. Furthermore, because the regasification rate is rapid during these months, when the occasion demands it, LNG storage could be depleted in less than 1 week.

During 1972, the total amount of gas moved into storage aggregated 1,892,952 MMcf, as shown in table 16. Over the same period, 1,757,218 MMcf was drawn down, leaving a net stored of 135,734 MMcf by the end of 1972.

Where depleted fields, whether oil or gas, are not available, other types of underground storage come into use. For example, there are 46 acquifers in nine States in which natural gas is stored. Illinois is the leader with 19; Indiana ranks second with 11 acquifers. Acquifer storage accounts for 21% of the storage total and 16.7% of the maximum daily withdrawal.

The development of storage reservoirs has been a factor in the growth of natural gas demand, particularly in the residential househeating market in which there is a high degree of seasonal variation. Furthermore, the concentration of storage relatively close to the largest markets for residential heating is another very large plus value. Pennsylvania, for example, had 574.1 billion cubic feet of natural gas stored in 68 dry-gas reservoirs at the end of 1972. In Illinois, there were 508.3 billion cubic feet; Michigan was third with 376.6 billion cubic feet of stored gas. Both Ohio and West Virginia had about 350 billion cubic feet of gas stored. In the aggregate, these five States accounted for 2,159.8 billion cubic feet or 61.3% of the total gas in storage, as shown in table 15.

VALUE AND PRICE

Marketed production of natural gas again increased in value in 1972. Values aggregated $4,185,869,000 as compared with a revised total of $4,085,482,000 in 1971 or an increase of 2.5%. These values are based on marketed production of 22,531,698,000 Mcf in 1972 with an average value of 18.6 cents per Mcf. In 1971, marketed production totaled 22,493,012,000 Mcf with an average value of 18.2 cents per Mcf as indicated in table 17. Two States, Texas and Louisiana, accounted for 72.8% of the total marketed production valued at $4,185,869,000 and when Oklahoma and New Mexico are included, the four States account for 87.2% of production and 85.2% of value.

Part of the increase in marketed production was offset by the decline, in Louisiana, of 109 billion cubic feet in volume and a $6 million drop in value. Texas in contrast, reported 107 MMcf or a 1.3% gain in marketed production and a $43 million or a 3% increase in value. At the other end of the spectrum are those States close to markets or doing a sizable intrastate volume relative to total marketed production. In the intrastate category is Alabama. With startups of natural gas processing plants, of which sulfur recovery facilities are an intregal part, production increased tenfold and values jumped from 15.1 cents per Mcf in 1971 to 35.2 cents per Mcf in 1972. Likewise, in Mississippi, and expansion in intrastate sales, which are not under FPC regulations, is reflected in the year-to-year increase from 20.9 cents per Mcf in 1971 to 27.0 cents per Mcf in 1972. In those States relatively close to large markets, such as New York, Pennsylvania, and West Virginia, values increased as evidenced in table 17.

In California, however, although gas-well production increased 10.7 million Mcf, there has been a 20.5% drop in marketed natural gas resulting from a decrease of 34,647,000 Mcf in the production of gas from oil wells. Overall values dropped about $20.4 million. The precipitous drop in California's natural gas production is occurring at a time when oil production is holding at a high level. Part of this decline is attributable to the use of gas in secondary recovery projects, primarily in the Coles Leves North, and Coles Leves

South fields in the Bakersfield area of California.

Wholesale Prices.—The increase in wholesale prices for gas also has been significant, particularly in those markets which have substantial use of gas for residential heating. The FPC collects data on the average wholesale prices in large metropolitan areas. In 12 of the 14 areas surveyed by the FPC, residential heating provides a significant market for natural gas. A 5-year historical series of average wholesale natural gas prices in the 14 large metropolitan areas, in cents per Mcf, is shown in table 18.

Comparing July 1, 1972 prices with those prevailing on July 1, 1971, wholesale rates in 5 of the 14 cities increased by 1 cent to 4 cents or more per Mcf. From July 1, 1971, to July 1, 1972, rates increased nominally or were unchanged in three cities; rates increased by 5 cents or more in four other cities. In two other cities, Washington and Pittsburgh, Pa., there were decreases of 1.35 cents and 0.52 cents per Mcf, respectively.

The wholesale prices for gas for 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 must transport gas from the California-Oregon and California-Arizona State lines.

Retail Prices.—At the retail level, the Bureau of Labor Statistics (BLS) compiles price information for fuels and energy, relative to development of the BLS Consumer Price Index. Average prices for fuels and energy are published monthly for the 20 Standard Metropolitan Statistical Areas shown in table 19.

At retail, gas is sold by gas utilities either in therms or in Mcf units. A therm contains 100,000 Btu. For illustrative purposes, 1 cubic foot of natural gas contains about 1,000 Btu, so that 1 therm would be equivalent to about 100 cubic feet of natural gas and 100 therms to about 10 Mcf. Since both the average wellhead value and the FPC wholesale price series are on million-cubic-foot basis, the BLS retail price series shown in table 19 has been converted from 100 therms to 10 therms so that the retail price approximates the cost of 1 Mcf.

Although retail prices of natural gas have been moving upward for some time now, significant increases are a recent development as indicated in table 19. For example, the price of gas at retail was 1.447 for 10 therms in Boston in 1965. By the end of 1970 that price was 1.568 cents or 8.4% higher than in 1965. Between the end of 1970, and the end of 1972, however, the retail price of gas in Boston jumped from 1.568 cents to 1.814 cents or 15.7%, and New York prices from 1.363 to 1.660 or 21.8%. Further increases are a foregone conclusion in light of actions taken by the FPC in Opinions and Orders related to pricing.

In examining these retail prices it should be recognized that the 100-therm price is a "block price" for gas used for heating. The rate structure of utilities is broken into block meter rates. The first block contains a minimum charge. In 1973 monthly bills for 10 therms for uses other than heating ranged from $1.65 in Dallas to $5.56 in Boston. Most bills (23 cities) cluster between $2.50 and $4 monthly. Minimum charges are a standard characteristic of gas distributors' rate schedules. In those areas where gas for househeating is a major consideration in terms of gas used, the block meter rate, after the block containing the minimum charge, would be lower per therm. The prices shown in table 19 are not true "bill" prices, but "heating block (s) " prices.

FOREIGN TRADE

Exports of natural gas aggregated 78 billion cubic feet in 1972 and 61% of the total volume was shipped in liquid form from Port Nikiski, Alaska.

Exports of LNG continued at high levels in 1972. Exports to Japan aggregated 47,881,678 Mcf, valued at $26,694,585, as compared with 50,230,855 Mcf valued at $26,189,991 in 1971.

Exports via pipeline in 1972 were almost equally divided between Canada and Mexico. Pipeline exports to Canada nearly all of which exit at Detroit, increased 8.2% to 15,426,455 Mcf in 1972.

Likewise, exports of natural gas via pipelines to Mexico, have been trending upwards since 1965; from 9.5 billion cubic feet that year to nearly 15.8 billion cubic feet in 1971. There was a 7.6% decrease in exports to Mexico in 1972, primarily because of reduced sales to intrastate companies. Comparisons of exports in 1971 and 1972 are shown in table 20.

Imports of natural gas from Canada crossed the 1 trillion cubic feet mark in 1972. Imports from Canada aggregated 1,009,092,757 Mcf, an increase of 10.8%. The price of Canadian imported gas in 1972 increased about 10.6% over the 27.82 cents per Mcf in 1971. Imports from Canada in 1972 were valued at $310.5 million, a 22.5% increase over the 1971 total of $253.4 million in 1971. On a daily average basis, Canadian imports by pipelines averaged nearly 2,757 MMcf as compared with almost 2,496 MMcf per day in 1971.

Although imports from Canada have been growing, imports from Mexico have been moving in the opposite direction. In fact, imports from Mexico entering the United States at McAllen, Texas, were 60.7% lower in 1972, primarily because supplies available for export to the United States are diminishing rapidly. For example, in 1971, imports from Mexico were 20.7 billion cubic feet compared with 41.3 billion cubic feet in 1970. In 1972, imports from Mexico were cut again—this time to 8.1 billion cubic feet or an 80% reduction over the 2-year period. A comparison of 1972 developments with 1971 is shown in table 21.

In addition to pipeline imports, 674,028 barrels of LNG were imported. At 14.73 psia, these volumes are equivalent to 2,261,508 Mcf of natural gas. Nearly 90% of the LNG was received from Algeria; the remainder originated in Canada. These LNG imports are primarily for peak shaving. Relative to base-load gas, the El Paso Natural Gas Co. finalized negotiations in 1972 with the Algerian government to import 1 billion cubic feet of natural gas per day as LNG or a total of 9 trillion cubic feet over the 20-year contract period. This plan has been approved by the FPC. The gas is to be landed at Cove Point. Md., and at Elba Island near Savannah, Ga. Facilities to receive and store base-load LNG are to be built; also regasification plants and pipeline connections to move gas to markets will be essential adjuncts to these projects. However, base-load Algeria LNG imports are not expected before 1976.

WORLD REVIEW

Marketed production of natural gas, worldwide, climbed to a record high in 1972. World production aggregated 42,481,435 MMcf, according to preliminary estimates and, of this total, the United States accounted for 22,531,698 MMcf, or 53.0%. In 1968, the United States accounted for 61.7% of the world total marketed production.

The U.S.S.R. was second to the United States, accounting for 18.5% of world production. During 1972, marketed production in the U.S.S.R. was estimated to have been 7.8 trillion cubic feet, an increase over 1971 of 300 billion cubic feet. The trend upward continued as the U.S.S.R. established new markets, primarily in Western Europe. The completion of a natural gas pipeline across Czechoslovakia paved the way to move Soviet natural gas to Italy and West Germany, The new line connects the Soviet Union and Austria.

A consortium of German steel manufacturers have contracted to deliver 1,200,000 tons of large diameter pipe to the Soviet Union. Repayment will be made in large-scale deliveries of natural gas to West Germany. Total deliveries to West Germany, Italy, Austria, Finland, and France are expected to reach 700 billion cubic feet by the late 1970's.

The cooperation of American oil, gas, and engineering companies to assist in the development of Soviet resources has received impetus from the policy formulated between the United States and the U.S.S.R. in May 1972.

In July 1972, the Occidental Petroleum Corp. signed a 5-year scientific and technical agreement with the State Committee for Science and Technology of the Council of Ministers of the U.S.S.R. This agreement covers exploration, production, and usage of oil and gas; agricultural fertilizers and chemicals; metal treating and metal plating; as well as the utilization of solid wastes. As a result of this agreement, there is a strong likelihood that natural gas will be available from Siberia for export as LNG to the United States, both to east coast and west coast.

Japan proposes, also, to participate in this development work so that some of the Soviet natural gas may become available for Japanese needs. It is estimated that proven reserves of natural gas in the U.S.S.R. are about 18 trillion cubic meters or about 636 trillion cubic feet.

Other American companies, such as El Paso Natural Gas, Bechtel International, Texas Eastern Transmission, Tenneco Corp., and Brown & Root, Inc., have been negotiating with the Soviet Union relative to development of its oil and gas supply potential.

Natural gas production in Canada was 2,913,645 MMcf in 1972 compared with 2,499,024 MMcf in 1971, an increase of 414.6 billion cubic feet or 16.6%.

Canada ranks third in natural gas production, exceeded only by the United States and the Soviet Union. About 40% of the total natural gas produced in Canada is exported to the United States, a fact that has caused concern about the availability of energy for needs in Canada. As a result, the National Energy Board has placed restrictions on exports of liquid hydrocarbons and natural gas. Similar to the case in the United States, air pollution controls and fuel use restrictions are swelling the demand for gas in Canada. This action was motivated, in part at least, by a report, completed in December 1972,[8] which was decidedly pessimistic about the long-term supply of conventional oil and gas resources.

Meanwhile, exploration and new oil and gas discoveries in the "frontier" regions, the Mackenzie Delta and Arctic Islands in the far north, and along the Atlantic offshore shelf in the east were encouraging. In fact, major reserves of natural gas have already been established in the Delta and in the Arctic Islands by Canadian and American oil and gas transmission companies and groups. Also a joint Canadian Government and industry venture, which is exploring and drilling in the Arctic Islands from the Benfort Sea to Baffin Bay, has blocked out large reserves of natural gas. It is estimated that natural gas reserves blocked out so far are at the 15-trillion-cubic-foot mark. In addition, exploration has intensified along Canada's east coast. The Department of Energy, Mines, and Resources has issued permits on 300 million acres in the Atlantic and Gulf of St. Lawrence. Discoveries in the Scotian shelf area around Sable Island have been most promising; capital from U.S. companies is playing an important role in the search and development of the Canadian oil and natural gas potential.

Marketed production from the Netherlands in 1972 totaled 2,052,443 MMcf. This volume is 515,944 MMcf, or 33.6% greater than in 1971 and 1,565,350 MMcf or more than 4 times greater than in 1968. Likewise, gas sales continued to boom in the Netherlands and it is estimated that natural gas sales totaled 58,000 million cubic meters or 2,048,270 MMcf in 1972.

Natural gas from the Netherlands has become a premium fuel for Western Europe so that there has been a significant drain on the country's gas reserves. As a result, the Netherlands Government placed a ban on new gas export contracts with West Germany until substantial new natural gas reserves are found.

Meanwhile, the Netherlands Government has granted 16 companies or groups of companies exploration licenses to drill for oil and gas offshore in the Netherlands. A number of these blocks of offshore acreage are shaping up as promising gasfields, and exploration is just beginning to gather momentum.

Romania ranks fifth in natural gas production. It is estimated that production in 1972 was about 954,000 MMcf or about 2% higher than the 943,568 MMcf produced in 1971. Most of the gas produced is used internally. Industry use, for fuel and petrochemical feedstocks, is an important consumer of gas in Romania.

The North Sea remains one of the most promising natural gas areas of the world outside the Soviet Union and the Middle East. Estimates by the United Kingdom, Norway, and the Netherlands of gas reserves range widely, from about 70 to 140 trillion cubic feet. In addition, there are production areas offshore of Denmark, France, and West Germany. In the 7-month period, January-July 1972, the total production of British North Sea gas averaged 2,507.5 MMcf per day or a 47.9% in-

[8] An Energy Policy for Canada Phase I. V. 1, Analysis; v. 2 Appendices; Summary of Analysis Department of Energy, Mines and Resources, Ottawa. Available, Information Canada, Ottawa—price $10.00.

crease over the 1,695.8 MMcf per day in the comparable 1971 period. Further increases are expected as a result of new discoveries north and east of Scotland and the gas discovery northwest of the Frigg gasfield which brackets the United Kingdom-Norway median line.

Algeria's marketed production is becoming a very important factor to the United States in view of long-range plans to import natural gas as LNG. The El Paso Natural Gas Co. contracted initially with Société Nationale pour la Recherche, la Production, le Transport, la Transformation et la Commercialisation des Hydrocarbures (SONATRACH) to import LNG averaging 1 billion cubic feet per day of gas rated at 1,125 Btu's per cubic foot. This was the first base-load contract to import LNG on a large scale.

Subsequently, a contract was made to purchase another 1 billion cubic feet per day, lifting the total to an average of 2 billion cubic feet a day over a 25-year period. However, the FPC has yet to approve the second 1 billion-cubic-feet-per day contract between SONATRACH and El Paso. In addition, a contract has been made with Distrigas Corp., of Boston to provide 50 MMcf per day over a 20-year period. Also, Eascogas LNG, Inc., agreed to buy 120 billion cubic meters (4,238 Mcf) over a 22-year period. This was a relatively recent transaction. In addition, SONATRACH has been negotiating with companies from West Germany, Belgium, France, and Spain to supply Europe with LNG over the longer term.

TECHNOLOGY

The predicted scarcity in natural gas supplies over the longer term has stimulated action on the part of industry and Government to spearhead research in the development of the gasification of coal, to obtain a high-Btu gas which is virtually the same in characteristics as pipeline-quality natural gas.

Construction of a $12-million facility at Bruceton, Pa., to demonstrate the Bureau of Mines coal gasification process is expected to be finished in August 1974. When completed, the pilot plant will be capable of processing about 75 tons of raw coal per day into substitute natural gas. The gasifier is designed to operate at 1,000 pounds per square inch and 1,800° F, and to produce 100,000 standard cubic feet per hour (SCFH) of coal gas. One fourth of the raw gas will be further processed to produce 13,000 SCFH of pipeline-quality gas. The pilot plant will be operated on a variety of U.S. coals to provide definitive process information on which to design a commercial coal-to-synethic natural gas (SNG) plant. A commercial plant would have a capacity of 250 MMcf of pipeline-quality gas per day.

Liquid gasification, that is synthesis of pipeline quality gas from petroleum hydrocarbons, has been attained in two liquid gasification plants. In fact, two plants, one in Harrison, N.J., and the other in Marysville, Mich., have been tested and found operable. There are within the United States, 31 plants for which plans have been announced to build gasification facilities. A summary of proposed LSNG plant construction is as follows:

Feedstock	Number of plants	Feedstock (barrels per day)	LSNG production (million cubic feet per day)
Naphtha	[1] 19	749,200	2,873
Natural gas liquids	4		
Propane/butane	3	17,860	70
Crude oil	[1] 5	780,000	[2] 1,680
Total	31	1,547,060	4,623

[1] Feedstock requirements and LSNG production of one naphtha plant and two crude oil plants not available. Only 18 naphtha plants are identifiable.
[2] Plus low-sulfur fuel oil production of 341,000 to 446,000 barrels per day.

As shown in the tabulation, more than half of the plants are designed to operate on naphtha as a feedstock and most of these proposed plants are to be located along the eastern seaboard in order to be accessible to naptha imported from Western Europe and the Caribbean areas. The LSNG plant in Harrison, N.J., is using domestic naphtha as a feedstock. The other LSNG plant in Marysville, Mich., is using natural gas liquids, part of which is obtained from Canadian sources and partly from U.S. sources.

Nuclear stimulation is another procedure for augmenting the supply of natural gas. The Atomic Energy Commission has conducted three experiments to determine the feasibility of using nuclear stimulation in the recovery of natural gas in tight formations. The first, the 1967 Gas Buggy experiment in New Mexico was a 29-kiloton shot. Subsequently, a 43-kiloton shot was made at Rulison in Colorado in 1969. Both of these shots proved that the flow of gas could be stimulated, but there was some tritium contamination.

The third experiment, also in Colorado, was the Project Rio Blanco Phase I which consisted of the near simultaneous detonation of three 30-kiloton nuclear explosives spaced one above the other more than 1 mile underground. The detonation has taken place but reentry into the well will not occur until September 1973.

Table 2.—Gas industry failures reported during 1971–72[1]

Cause	Total number of failures		Fatalities: Employees		Fatalities: Non-employees		Injuries: Employees		Injuries: Non-employees		Estimated property damage (value)	
	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972
Distribution:												
Corrosion	120	121	--	--	3	2	9	9	30	56	$297,474/$574,146	
Damage by outside forces	575	630	--	--	13	20	8	15	138	141		
Construction defect or material failure	121	90	--	1	16	3	4	3	111	52		
Other causes	61	43	6	1	4	1	16	5	51	13		
Total	877	884	6	2	36	26	37	32	330	262	297,474	574,146
Transmission:												
Corrosion	55	74	1	--	--	--	6	--	--	--	2,632,170/2,424,747	
Damage by outside forces	213	219	--	--	1	--	--	8	6	4		
Construction defect or material failure	105	80	--	--	--	2	--	4	3	1		
Other causes	37	36	1	3	--	1	8	11	1	8		
Total	410	409	2	3	1	3	14	23	10	13	2,632,170	2,424,747
Grand total	1,287	1,293	8	5	37	29	51	55	340	275	2,929,644	2,998,893

[1] In addition to above data compiled from written gas pipeline failure reports received by the Office of Pipe line Safety (OPS) during 1972, there were two fatalities and 39 injuries resulting from gas distribution incidents and one injury resulting from a transmission line failure, all of which occurred in 1972 but were not reported until after December 31. Also, additional incidents reported to OPS by telephonic notice during 1972, but which did not require follow-up written reports, indicated that there were 18 fatalities and 64 injuries from distribution system failures.

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]
1971						
Alabama	2	661	663	355	--	308
Alaska	125,169	103,003	226,172	121,618	72,674	33,880
Arizona	873	342	1,215	868	--	347
Arkansas	120,454	54,429	174,883	172,154	995	1,734
California	293,254	385,990	679,244	612,629	66,040	575
Colorado	84,303	29,037	113,340	108,537	1,960	2,843
Florida	--	1,258	1,258	903	--	355
Illinois	498	3,997	4,495	498	--	3,997
Indiana	537	--	537	537	--	--
Kansas	729,262	160,330	889,592	885,144	1,779	2,669
Kentucky	72,546	177	72,723	72,723	--	--
Louisiana	7,011,666	1,306,885	8,318,551	8,081,907	133,080	103,564
Maryland	214	--	214	214	—	--
Michigan	10,968	15,482	26,450	25,662	788	--
Mississippi	107,727	28,809	136,536	118,805	12,641	5,090
Missouri	22	--	22	22	--	--
Montana	31,195	6,941	38,136	32,720	499	4,917
Nebraska	3,028	2,026	5,054	3,496	--	1,558
New Mexico	861,520	308,880	1,170,400	1,167,577	--	2,823
New York	2,202	--	2,202	2,202	--	--
North Dakota	146	r 36,404	36,550	33,864	--	2,686
Ohio	61,845	18,058	79,903	79,903	—	--
Oklahoma	1,425,847	383,239	1,809,086	1,684,260	85,027	39,799
Pennsylvania	74,081	2,370	76,451	76,451	--	--
South Dakota	--	9	9	--	9	--
Tennessee	99	398	497	89	--	408
Texas	7,327,186	2,191,458	9,518,644	8,550,705	897,717	70,222
Utah	26,571	47,689	74,260	42,418	28,916	2,926
Virginia	2,619	--	2,619	2,619	--	--
West Virginia	232,205	2,109	234,314	234,027	287	--
Wyoming	319,097	72,914	392,011	380,105	8,046	3,860
Total	18,925,136	r 5,162,895	24,088,031	22,493,012	1,310,458	r 284,561
1972						
Alabama	2,601	2,009	4,610	3,644	--	966
Alaska	126,198	96,707	222,905	125,596	75,719	21,590
Arizona	431	378	809	442	--	367
Arkansas	125,319	43,852	169,171	166,522	--	2,649
California	304,049	251,343	555,392	487,278	68,114	--
Colorado	94,401	27,721	122,122	116,949	415	4,758
Florida	--	15,805	15,805	15,521	--	284
Illinois	1,194	1,806	3,000	1,194	--	1,806
Indiana	355	--	355	355	--	--
Kansas	751,921	141,815	893,736	889,268	1,787	2,681
Kentucky	63,648	--	63,648	63,648	--	--
Louisiana	6,924,204	1,235,559	8,159,763	7,972,678	123,418	63,667
Maryland	244	--	244	244	--	--
Michigan	13,523	21,730	35,253	34,221	--	1,032
Mississippi	94,320	25,377	119,697	103,989	12,036	3,672
Missouri	9	--	9	9	--	--
Montana	34,958	3,179	38,137	33,474	441	4,222
Nebraska	2,779	1,962	4,741	3,478	--	1,263
New Mexico	944,463	277,294	1,221,757	1,216,061	--	5,696
New York	3,679	--	3,679	3,679	--	--
North Dakota	122	34,794	34,916	32,472	--	2,444
Ohio	72,765	17,230	89,995	89,995	--	--
Oklahoma	1,435,726	492,223	1,927,949	1,806,887	82,265	38,797
Pennsylvania	71,498	2,460	73,958	73,958	--	--
South Dakota	8	--	8	--	8	--
Tennessee	25	180	205	25	--	180
Texas	7,409,894	2,140,575	9,550,469	8,657,840	832,808	59,821
Utah	25,783	49,881	75,664	39,474	30,684	5,506
Virginia	2,787	--	2,787	2,787	--	--
West Virginia	213,845	1,291	215,136	214,951	185	--
Wyoming	321,368	70,479	391,847	375,059	8,412	8,376
Total	19,042,117	4,955,650	23,997,767	22,531,698	1,236,292	229,777

[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.

Source: Figures based on reports received from State agencies and Bureau of Mines estimates.

Table 4.—Gas wells and condensate wells in the United States

PAD district and State	Completed during 1971 [1]	Completed during 1972 [1]	Producing as of Dec. 31, 1971 [2]	Producing as of Dec. 31, 1972 [2]
District 1:				
Maryland	--	--	14	16
New York	7	22	600	650
Pennsylvania	199	297	16,586	16,600
Florida	--	--	--	--
Virginia	--	18	115	130
West Virginia	496	488	21,025	21,324
Total	702	825	38,340	38,720
District 2:				
Illinois	16	18	14	31
Indiana	2	5	r 83	87
Kansas	112	368	8,585	8,621
Kentucky	135	166	7,413	7,099
Michigan	33	34	1,171	1,317
Missouri	1	--	2	3
Nebraska	1	2	29	29
North Dakota	1	--	29	21
Ohio	608	721	8,179	8,630
Oklahoma	238	341	8,507	8,457
Tennessee	23	9	20	45
Total	1,170	1,664	r 34,032	34,340
District 3:				
Alabama	6	9	--	15
Arkansas	29	39	1,013	1,041
Louisiana	621	818	9,748	9,456
Mississippi	13	13	400	252
New Mexico	186	238	9,388	9,679
Texas	810	943	23,280	23,373
Total	1,665	2,060	43,829	43,816
District 4:				
Colorado	148	124	928	934
Montana	33	125	1,056	1,116
Utah	6	13	178	200
Wyoming	43	52	840	887
Total	230	314	3,002	3,137
District 5:				
Alaska	1	2	40	50
Arizona	2	1	5	4
California	60	62	962	1,086
Nevada	--	--	--	--
Total	63	65	1,007	1,140
Total United States	3,830	4,928	r 120,210	121,153

r Revised.
[1] Source: American Association of Petroleum Geologists and American Petroleum Institute.
[2] Based on State estimates and State reports.

Table 5.—Gas and oil well completions in the United States, by State, 1967–72

	Gas Completions [1]						Oil Completions [2]					
	1967	1968	1969	1970	1971	1972	1967	1968	1969	1970	1971	1972
Alabama	--	1	1	5	6	9	9	9	10	7	8	13
Alaska	4	7	11	5	1	2	37	77	38	67	27	12
Arizona	2	--	2	--	2	1	6	4	9	1	--	5
Arkansas	70	46	40	36	29	39	132	103	151	100	127	96
California	72	77	59	56	60	62	2,045	2,191	1,543	1,697	1,459	1,045
Colorado	45	50	47	47	148	124	145	108	158	142	154	300
Florida	--	--	--	--	--	--	--	3	6	14	8	65
Georgia	--	--	--	--	--	--	--	--	--	--	--	--
Illinois	1	1	5	5	16	18	598	544	417	311	252	255
Indiana	5	14	7	4	2	5	148	122	129	93	81	92
Iowa	--	--	--	--	--	--	--	--	--	--	--	--
Kansas	147	90	184	108	112	368	1,264	1,210	1,271	1,044	1,099	880
Kentucky	200	205	142	111	135	166	528	383	296	275	244	230
Louisiana:												
North	175	143	123	157	237	451	325	310	309	263	390	291
South	164	210	230	232	200	234	464	560	471	497	398	375
Offshore	126	184	190	150	184	133	372	476	372	382	258	253
Total Louisiana	465	537	543	539	621	818	1,161	1,346	1,152	1,142	1,046	919
Michigan	26	28	15	19	33	34	65	73	73	49	81	87
Mississippi	15	12	16	12	13	13	226	161	195	211	175	87
Missouri	--	--	--	--	1	--	--	12	17	10	6	--
Montana	22	40	31	74	33	125	194	319	186	64	45	83
Nebraska	1	--	1	2	1	2	42	64	57	39	47	48
Nevada	--	--	--	--	--	--	1	--	--	--	--	--
New Mexico	257	150	263	159	186	238	594	512	561	341	401	502
New York	13	10	12	17	7	22	163	83	112	69	83	96
North Carolina	--	--	--	--	--	--	--	--	--	--	--	--
North Dakota	--	--	--	1	1	--	72	49	49	48	49	23
Ohio	214	230	395	683	608	721	792	726	645	503	391	426
Oklahoma	443	370	397	321	238	341	1,377	1,323	1,604	1,343	1,174	1,025
Pennsylvania	271	253	277	250	199	297	273	472	547	441	394	534
South Dakota	--	--	--	--	--	--	--	--	--	--	2	4
Tennessee	1	6	7	4	23	9	3	--	4	24	57	14
Texas	952	763	903	774	810	943	4,727	3,779	4,256	4,137	3,880	3,963
Utah	10	5	16	10	6	13	59	38	47	29	30	73
Viriginia	--	--	--	--	--	18	--	--	1	--	--	--
Washington	--	--	--	--	--	--	--	--	--	--	--	--
West Virginia	384	522	652	553	496	488	269	119	135	192	133	84
Wyoming	39	39	57	45	43	52	399	501	699	627	405	345
Grand total	3,659	3,456	4,083	3,840	3,830	4,928	15,329	14,331	14,368	13,020	11,858	11,306

[1] Includes multiple completion wells which produce gas from all zones.
[2] Includes multiple completion wells which 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 1967–1972 inclusive.

Table 6.—Consumption of natural gas by use and by State, 1972

(Million cubic feet at 14.73 psia)

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	$112,892	--	--	--	--	40	$14	64,008	$112,906
Maine, New Hampshire, Vermont	13,267	22,120	--	--	--	--	--	--	13,267	22,120
Massachusetts	159,623	299,260	--	--	--	--	657	242	160,280	299,502
Rhode Island	22,478	40,935	--	--	--	--	16	6	22,494	40,941
Total	259,336	475,207	--	--	--	--	713	262	260,049	475,469
Middle Atlantic:										
New Jersey	320,559	475,531	--	--	--	--	729	176	321,288	475,707
New York	689,329	902,919	--	--	--	--	3,401	898	692,730	903,817
Pennsylvania	798,559	813,277	70	$24	2,847	$1,335	27,555	8,459	829,031	823,095
Total	1,808,447	2,191,727	70	24	2,847	1,335	31,685	9,533	1,843,049	2,202,619
East North Central:										
Illinois	1,183,746	1,028,551	13,346	2,963	308	93	23,235	5,321	1,220,635	1,036,928
Indiana	563,723	441,502	--	--	--	--	13,225	3,306	576,948	444,808
Michigan	846,508	735,273	1,912	541	2,143	519	16,119	4,739	866,682	741,072
Ohio	1,131,681	965,295	--	--	3,397	1,403	12,726	3,525	1,147,804	970,223
Wisconsin	314,592	284,118	--	--	--	--	6,234	1,646	320,826	285,764
Total	4,040,250	3,454,739	15,258	3,504	5,848	2,015	71,539	18,537	4,132,895	3,478,795
West North Central:										
Iowa	324,247	229,998	--	--	--	--	20,269	4,054	344,516	234,052
Kansas	519,835	232,456	40,738	7,292	28,183	7,356	80,091	18,661	668,847	265,765
Minnesota	343,940	270,103	--	--	--	--	7,468	1,979	351,408	272,082
Missouri	415,596	314,769	--	--	--	--	9,619	2,376	425,215	317,145
Nebraska	210,624	131,482	539	102	814	182	13,124	2,336	225,101	134,102
North Dakota	23,437	21,242	3,199	819	12,773	2,286	263	65	39,672	24,412
South Dakota	34,067	26,313	--	--	--	--	10	3	34,077	26,316
Total	1,871,746	1,226,363	44,476	8,213	41,770	9,824	130,844	29,474	2,088,836	1,273,874
South Atlantic:										
Delaware	24,088	27,443	--	--	--	--	--	--	24,088	27,443
Florida	293,174	174,056	2,144	808	1,782	444	4,021	981	301,121	176,289
Georgia	323,186	243,488	--	--	--	--	7,957	1,798	331,143	245,286
Maryland, District of Columbia	201,254	249,106	--	--	67	32	3,601	864	204,922	250,002
North Carolina	157,826	130,823	--	--	--	--	6,071	1,366	163,897	132,189
South Carolina	141,114	104,347	--	--	--	--	3,006	718	144,120	105,065
Virginia	147,227	159,743	--	--	157	59	8,274	2,217	155,658	162,019
West Virginia	180,541	129,834	9,411	2,673	3,808	1,249	14,792	5,636	208,552	139,392
Total	1,468,410	1,218,840	11,555	3,481	5,814	1,784	47,722	13,580	1,533,501	1,237,685

East South Central:										
Alabama	258,331	165,798	243	50	1,070	406	19,066	4,385	278,710	170,639
Kentucky	216,749	157,881	6,063	1,310	1,509	353	36,950	8,794	261,271	168,338
Mississippi	310,950	141,575	1,058	252	9,153	1,748	57,883	13,255	379,044	156,830
Tennessee	250,741	166,617	--	--	1,150	389	25,384	5,838	277,275	172,844
Total	1,036,771	631,871	7,364	1,612	12,882	2,896	139,283	32,272	1,196,300	668,651
West South Central:										
Arkansas	298,484	130,975	1,197	301	4,740	1,085	13,151	3,143	317,572	135,504
Louisiana	1,548,083	542,612	197,967	59,588	312,145	65,550	79,534	18,293	2,137,729	686,043
Oklahoma	506,377	195,797	56,376	12,628	98,784	15,904	24,596	4,722	686,133	229,051
Texas	3,506,146	1,166,330	470,105	147,613	802,112	148,391	104,378	19,727	4,882,741	1,482,061
Total	5,859,090	2,035,714	725,645	220,130	1,217,781	230,930	221,659	45,885	8,024,175	2,532,659
Mountain:										
Arizona	201,968	124,665	--	--	44	8	25,897	4,791	227,909	129,464
Colorado	302,033	158,442	4,114	975	4,676	753	2,994	623	313,817	160,793
Idaho	51,908	43,686	--	--	--	--	4,722	1,322	56,630	45,008
Montana	77,348	48,764	839	152	5,924	954	1,050	174	85,161	50,044
Nevada	69,522	48,348	--	--	--	--	--	--	69,522	48,348
New Mexico	202,884	98,396	54,157	9,965	48,803	7,076	36,306	6,571	342,150	122,008
Utah	121,264	72,966	3,382	818	1,978	354	851	237	127,475	74,375
Wyoming	97,354	42,478	16,228	3,116	22,402	3,451	6,078	1,070	142,062	50,115
Total	1,124,281	637,745	78,720	15,026	83,827	12,596	77,898	14,788	1,364,726	680,155
Pacific:										
Alaska	49,818	40,223	749	203	16,056	3,597	8,784	2,451	75,407	46,474
California	2,098,094	1,411,749	24,156	10,798	68,738	22,065	18,711	6,586	2,209,699	1,451,198
Oregon	100,436	94,028	--	--	--	--	9,924	2,769	110,360	96,797
Washington	163,054	131,436	--	--	--	--	7,394	2,078	170,448	133,514
Total	2,411,402	1,677,436	24,905	11,001	84,794	25,662	44,813	13,884	2,565,914	1,727,983
Total United States	19,879,733	13,549,642	907,993	262,991	1,455,563	287,042	766,156	178,215	23,009,445	14,277,890

Table 7.—Production of natural gas liquids at natural gas processing plants, and disposition of residue gas in the United States in 1971–72, 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 or flared	Shipped to transmission companies	Direct deliveries to consumers	Unaccounted for	Total
1971:										
Arkansas	1,552	31,387	2,563	3,663	436	27	15,812	8,886	--	28,824
California and Alaska	17,865	431,605	27,684	24,512	193,284	r 4,894	123,825	r 52,498	4,908	403,921
Colorado	2,582	97,420	4,152	2,481	6,818	236	83,941	102	−310	93,268
Kansas	28,602	1,451,438	39,741	7,755	1,509	63	1,343,300	59,384	−314	1,411,697
Kentucky and Illinois	13,020	341,750	19,653	1,025	--	--	318,002	2,730	340	322,097
Louisiana	144,695	5,994,431	195,072	98,786	120,771	2,388	4,890,254	691,788	−4,628	5,799,359
Michigan	1,528	141,784	2,013	1,989	480	--	137,374	--	−72	139,771
Mississippi and Alabama	1,078	44,732	1,498	1,349	7,067	--	33,268	1,428	122	43,234
Montana and Utah	2,861	57,105	4,572	4,628	18,585	1,731	27,260	--	329	52,533
Nebraska	490	2,848	599	235	13	--	1,843	154	4	2,249
New Mexico	37,034	1,124,139	53,810	54,695	5,809	2,437	834,340	161,100	11,948	1,070,329
North Dakota	2,124	33,252	3,592	4,960	6,960	93	17,064	264	319	29,660
Oklahoma	41,737	1,123,614	55,914	48,313	86,190	401	819,797	110,680	2,319	1,067,700
Pennsylvania	39	1,112	55	--	--	--	1,057	--	--	1,057
Texas	306,721	7,938,550	448,288	305,216	894,667	20,738	5,487,688	754,698	27,255	7,490,262
West Virginia and Florida	7,899	145,206	11,119	3,899	28	--	128,438	1,722	--	134,087
Wyoming	7,988	292,434	12,802	9,481	12,387	108	246,743	12,162	−1,249	279,632
Total	617,815	19,252,807	883,127	572,987	1,355,004	r 33,116	14,510,006	r 1,857,596	40,971	18,369,680
1972:										
Arkansas	807	17,946	1,197	3,056	241	14	10,176	3,262	--	16,749
California and Alaska	14,913	386,664	24,905	22,240	201,614	7,028	91,175	35,771	3,931	361,759
Colorado	2,994	104,116	4,114	2,787	5,148	240	91,938	--	−111	100,002
Kansas	30,604	1,497,319	40,738	9,268	1,884	82	1,374,268	71,362	−283	1,456,581
Kentucky and Illinois	12,707	376,310	19,409	2,716	--	--	351,114	2,933	138	356,901
Louisiana	151,075	6,337,328	197,967	106,614	123,331	3,022	5,190,052	719,411	−3,069	6,139,361
Michigan	1,228	94,738	1,912	1,624	811	113	90,582	--	−304	92,826
Mississippi and Alabama	829	29,538	1,301	1,426	4,837	--	21,116	826	32	28,237
Montana and Utah	2,841	61,757	4,221	4,371	19,867	1,076	31,718	--	504	57,536
Nebraska	416	2,890	539	251	--	--	2,097	--	3	2,351
New Mexico	38,197	1,126,192	54,157	53,218	5,528	2,714	856,568	146,671	7,336	1,072,035
North Dakota	2,013	32,131	3,199	3,923	6,849	83	17,808	85	184	28,932
Oklahoma	41,707	1,116,872	56,376	45,604	76,872	207	842,165	92,869	2,779	1,060,496
Pennsylvania	53	1,711	70	--	--	--	1,641	--	--	1,641
Texas	319,061	8,139,408	470,105	317,136	931,461	9,825	5,566,168	811,374	33,339	7,669,303
West Virginia and Florida	8,065	324,381	11,555	4,119	22	--	307,825	797	63	312,826
Wyoming	10,706	298,439	16,228	9,692	13,636	566	248,432	9,407	478	282,211
Total	638,216	19,947,740	907,993	588,045	1,392,101	24,970	15,094,843	1,894,768	45,020	19,039,747

r Revised.

Table 8.—Firm requirements and firm requirement deficiencies reported to the FPC by major pipelines

(Million cubic feet)

Reporting company	1972 (actual) [1]			1972–1973 (actual) [1]			1973 (estimated) [2]			1972–1973 (estimated) [2]		
	April–October			November–March			April–October			November–March		
	Firm requirement	Volume curtailed	% curtailment	Firm requirement	Volume curtailed	% curtailment	Firm requirement	Volume curtailed	% curtailment	Firm requirement	Volume curtailed	% curtailment
Algonquin Gas Transmission Co.	74,099	320	0.4	85,065	8,485	10.0	72,693	12,568	17.3	102,977	10,664	10.4
Arkansas Louisiana Gas Co.	270,592	61,331	22.7	248,450	76,257	30.7	264,138	79,604	30.1	231,410	43,098	18.6
Cities Service Gas Co.	273,051	[3] 31	--	303,716	43,000	14.2	281,686	10,000	3.6	291,102	22,000	7.6
Colorado Interstate Gas Co.	205,714	--	--	207,430	--	--	211,871	--	--	210,255	--	--
Columbia Gas Transmission Corp.	625,477	--	--	823,817	--	--	659,477	--	--	870,964	9,060	1.0
Consolidated Gas Supply Corp.	345,747	--	--	536,015	--	--	345,814	10,318	3.0	577,944	--	--
East Tennessee Natural Gas Co.	51,299	--	--	45,445	--	--	53,401	--	--	46,628	--	--
El Paso Natural Gas Co.	1,034,070	553	.1	829,930	66,847	8.1	1,079,320	555	.1	827,427	66,848	8.1
Florida Gas Transmission Co.	12,223	--	--	15,478	--	--	13,537	--	--	19,094	--	--
Granite State Gas Transmission Inc.	20,355	--	--	23,863	--	--	21,880	--	--	25,687	--	--
Great Lakes Gas Transmission Co.	223,867	--	--	180,683	--	--	245,220	--	--	180,749	--	--
Kansas-Nebraska Natural Gas Co., Inc.	66,930	--	--	65,245	--	--	71,005	--	--	64,790	--	--
Louisiana-Nevada Transit Co.	79,874	77	.1	64,615	432	.7	77,716	--	--	69,555	--	--
Michigan Wisconsin Pipeline Co.	407,723	--	--	480,954	--	--	425,635	--	--	498,082	--	--
Mid-Louisiana Gas Co.	199,325	--	--	150,048	314	.2	199,600	--	--	150,657	--	--
Midwestern Gas Transmission Corp.	20,285	--	--	17,802	--	--	16,871	--	--	17,458	--	--
Mississippi River Transmission Corp.	81,368	--	--	122,659	9,217	7.5	86,475	--	--	122,821	7,821	6.4
Montana-Dakota Utilities Co.	11,724	--	--	23,314	--	--	12,161	--	--	25,398	--	--
Mountain Fuel Supply Co.	19,773	--	--	42,730	--	--	22,175	--	--	42,867	--	--
Natural Gas Pipeline Co. of America	700,481	145,489	20.8	505,198	--	--	698,931	225,400	32.2	508,208	--	--
Northern Natural Gas Co.	455,835	1,777	.4	410,490	4,769	1.2	489,066	5,800	1.2	406,934	6,000	1.5
Pacific Gas Transmission Co.	238,648	--	--	180,181	--	--	239,054	--	--	176,791	--	--
Panhandle Eastern Pipe Line Co.	442,856	--	--	393,056	14,505	3.7	438,839	4,069	.9	386,869	31,014	8.0
South Georgia Natural Gas Co.	14,704	--	--	10,457	--	--	14,980	--	--	10,570	--	--
Southern Natural Gas Co.	309,441	--	--	287,465	--	--	323,049	--	--	292,894	--	--
Tennessee Gas Pipeline Co.	727,287	--	--	591,524	--	--	758,286	--	--	614,251	--	--
Texas Eastern Transmission Corp.	544,734	38,493	7.1	427,532	61,644	14.4	587,399	95,592	16.3	489,644	68,585	14.0
Texas Gas Transmission Corp.	405,128	--	--	337,604	--	--	412,121	--	--	347,849	--	--
Transcontinental Gas Pipe Line Corp.	636,683	46,760	7.3	449,845	30,588	6.8	645,046	87,969	13.6	451,491	72,027	16.0
Transwestern Pipeline Co.	198,497	--	--	148,525	1,044	.7	207,299	4,031	1.9	152,897	21,217	13.9
Trunkline Gas Co.	345,792	27,533	8.0	247,664	53,326	21.5	345,792	75,009	21.7	252,194	76,398	30.3
United Gas Pipe Line Co.	891,015	233,025	26.2	699,821	195,172	27.9	900,639	299,935	33.3	702,159	235,435	33.5
Total	9,934,597	555,389	5.6	8,956,621	565,600	6.3	10,221,176	910,850	8.9	9,168,616	670,167	7.3
Less intercompany transactions	XX	[4] 154,074	XX	XX	[4] 142,717	XX	XX	[5] 252,305	XX	XX	[5] 168,882	XX
Net curtailments	XX	401,315	XX	XX	422,883	XX	XX	658,544	XX	XX	501,285	XX

XX Not applicable.

[1] Firm requirements as reported in Gas Supply-Requirement Balance. Volume curtailed as reported in FPC Form 17.

[2] All volumes reported in Gas Supply-Requirement Balance.

[3] Cities Service did not file Form 17 reports. The volumes shown were reported in Gas Supply-Requirement Balance. The company states "our entire contractual demands for gas on our system although some volumes of gas sold and delivered to distributors for resale and to direct customers are interruptible."

[4] Intercompany transactions as obtained from FPC Form 17.

[5] Estimated intercompany transactions.

Source: Federal Power Commission.

Table 9.—Marketed production, interstate shipments, and total consumption of natural gas in the United States, 1972

(Million cubic feet)

State by region	Marketed production	Interstate movements: Receipts	Interstate movements: Deliveries	Interstate movements: Net receipts (+) or deliveries (−)	Change in underground storage	Transmission loss and unaccounted for	Consumption
New England:							
Connecticut	--	162,824	95,939	66,885	--	2,877	64,008
Maine, New Hampshire, Vermont	--	14,027	--	14,027	--	760	13,267
Massachusetts	--	191,749	25,033	166,716	1,074	5,362	160,280
Rhode Island	--	101,359	77,868	23,491	--	997	22,494
Total	--	469,959	198,840	271,119	1,074	9,996	260,049
Middle Atlantic:							
New Jersey	--	828,129	495,237	332,892	−20	11,624	321,288
New York	3,679	949,720	265,808	683,912	−10,117	4,978	692,730
Pennsylvania	73,958	2,074,454	1,307,827	766,627	−7,071	18,625	829,031
Total	77,637	3,852,303	2,068,872	1,783,431	−17,208	35,227	1,843,049
East North Central:							
Illinois	1,194	2,470,725	1,201,533	1,269,192	39,910	9,841	1,220,635
Indiana	355	2,106,027	1,517,039	588,988	−76	12,471	576,948
Michigan	34,221	823,515	15,426	808,089	−31,031	6,659	866,682
Ohio	89,995	2,995,531	1,947,957	1,047,574	−21,570	11,335	1,147,804
Wisconsin	--	436,534	105,675	330,859	--	10,033	320,826
Total	125,765	8,832,332	4,787,630	4,044,702	−12,767	50,339	4,132,895
West North Central:							
Iowa	--	1,402,943	1,052,903	350,040	7,279	−1,755	344,516
Kansas	889,268	2,194,730	2,411,550	−216,820	−1,581	5,182	668,847
Minnesota	--	591,465	235,116	356,349	--	4,941	351,408
Missouri	9	1,717,673	1,282,951	434,722	1,496	8,020	425,215
Nebraska	3,478	1,458,769	1,220,005	238,764	6,555	10,586	225,101
North Dakota	32,472	17,739	9,401	8,338	--	1,138	39,672
South Dakota	--	36,164	1,351	34,813	--	736	34,077
Total	925,227	7,419,483	6,213,277	1,206,206	13,749	28,848	2,088,836
South Atlantic:							
Delaware	--	25,962	1,966	23,996	--	−92	24,088
Florida	15,521	287,250	--	287,250	--	1,650	301,121
Georgia	--	1,400,727	1,064,294	336,433	--	5,290	331,143
Maryland and District of Columbia	244	882,661	670,572	212,089	−272	7,683	204,922
North Carolina	--	893,642	725,356	168,286	--	4,389	163,897
South Carolina	--	1,044,679	893,642	151,037	--	6,917	144,120
Virginia	2,787	1,028,270	870,773	157,497	185	4,441	155,658
West Virginia	214,951	1,430,913	1,429,773	1,140	−22,163	29,702	208,552
Total	233,503	6,994,104	5,656,376	1,337,723	−22,250	59,980	1,533,501

East South Central:							
Alabama	3,644	3,280,337	2,999,002	281,335	129	6,140	278,710
Kentucky	63,648	3,967,250	3,750,891	216,359	8,299	10,437	261,271
Mississippi	103,989	6,582,428	6,222,130	360,298	75,604	9,639	379,044
Tennessee	25	4,259,140	3,975,797	283,343	--	6,093	277,275
Total	171,306	18,089,155	16,947,820	1,141,335	84,032	32,309	1,196,300
West South Central:							
Arkansas	166,522	2,862,507	2,687,122	175,385	129	24,206	317,572
Louisiana	7,972,678	1,247,034	7,069,882	−5,822,848	−533	12,634	2,137,729
Oklahoma	1,806,887	1,422,394	2,531,603	−1,109,209	−7,791	19,336	686,133
Texas	8,657,840	558,825	4,300,891	−3,742,066	39,982	−6,949	4,882,741
Total	18,603,927	6,090,760	16,589,498	−10,498,738	31,787	49,227	8,024,175
Mountain:							
Arizona	442	1,697,235	1,465,023	232,212	--	4,745	227,909
Colorado	116,949	330,661	126,293	204,368	−522	8,022	313,817
Idaho	--	515,851	455,378	60,473	--	3,843	56,630
Montana	33,474	66,701	12,490	54,211	1,520	1,004	85,161
Nevada	--	71,214	--	71,214	--	1,692	69,522
New Mexico	1,216,061	1,036,716	1,902,655	−865,939	--	7,972	342,150
Utah	39,474	236,460	135,143	101,317	215	13,101	127,475
Wyoming	375,059	83,781	314,196	−230,415	7,190	−4,608	142,062
Total	1,781,459	4,038,619	4,411,178	−372,559	8,403	35,771	1,364,726
Pacific:							
Alaska	125,596	--	47,882	−47,882	--	2,307	75,407
California	487,278	1,778,649	--	1,778,649	45,671	10,557	2,209,699
Oregon	--	487,064	371,989	115,075	--	4,715	110,360
Washington	--	682,145	499,728	182,417	3,243	8,726	170,448
Total	612,874	2,947,858	919,599	2,028,259	48,914	26,305	2,565,914
Total United States	22,531,698	[1] 58,734,573	[2] 57,793,090	941,483	135,734	328,002	23,009,445

[1] Includes receipts from Canada of 434,836 MMcf into Idaho; 256,856 MMcf into Minnesota; 255,496 MMcf into Washington; 48,589 MMcf into Montana; 9,571 MMcf into New York; 3,745 MMcf into Vermont; and from Mexico 8,141 MMcf into Texas; and liquefied natural gas (gaseous equivalent) imports into Massachusetts of 2,032 MMcf from Algeria and 230 MMcf from Canada.

[2] Includes deliveries to Canada of 15,426 MMcf from Michigan; 127 MMcf from Montana and into Mexico; 10,057 MMcf from Texas; 4,521 MMcf from Arizona; and liquefied natural gas exports of 47,882 MMcf to Japan from Alaska.

Table 10.—Interstate pipeline movements of natural gas in the United States

(Billion cubic feet at 14.73 psia)

State and region	Receipts from				Deliveries to				Net receipts
	Within region		Outside region		Within region		Outside region		
	State	Quantity	State	Quantity	State	Quantity	State	Quantity	
New England:									
Connecticut	Massachusetts	9.3	New York	153.5	Rhode Island	95.9	--	--	66.9
Maine, New Hampshire, Vermont	Massachusetts	10.3	Canada	3.7	--	--	--	--	14.0
Massachusetts	Rhode Island	72.4	New York	111.6	Connecticut	9.3	--	--	166.7
	--	--	Algeria	2.0	New Hampshire	10.3	--	--	--
	--	--	Canada	0.2	--	--	--	--	
Rhode Island	Connecticut	95.9	--	--	Massachusetts	72.4	--	--	23.5
Total	--	187.9	--	271.0	--	187.9	--	--	271.1
Middle Atlantic:									
New Jersey	Pennsylvania	827.6	--	--	New York	494.7	--	--	332.9
New York	New Jersey	494.7	Canada	9.6	--	--	Connecticut	153.5	683.9
	Pennsylvania	444.7	--	--	--	--	Massachusetts	111.6	--
Pennsylvania	--	--	West Virginia	789.4	New York	444.7	Delaware	26.0	766.6
	--	--	Maryland	669.5	--	827.6	--	--	--
	--	--	Ohio	606.1	--	--	--	--	--
Total	--	1,767.0	--	2,074.6	--	1,767.0	--	291.1	1,783.4
East North Central:									
Illinois	--	--	Missouri	1,086.0	Indiana	811.4	--	--	1,269.2
	--	--	Iowa	693.3	Wisconsin	206.8	--	--	--
	--	--	Kentucky	508.1	--	--	--	--	--
Indiana	Illinois	811.4	Kentucky	1,111.3	Ohio	1,333.7	--	--	589.0
Michigan	Ohio	717.8	--	--	--	--	Canada	15.4	808.1
	Wisconsin	105.7	--	--	--	--	--	--	--
Ohio	Indiana	1,333.7	Kentucky	1,334.2	Michigan	717.8	Pennsylvania	606.1	1,047.6
							West Virginia	296.4	--
Wisconsin	Illinois	206.8	Minnesota	229.7	Michigan	105.7	--	--	330.9
Total	--	3,175.4	--	4,962.6	--	3,175.4	--	917.9	[1]4,044.7

West North Central:									
Iowa	Nebraska	1,205.6	--	--	Minnesota	334.2	Illinois	693.3	350.0
	Missouri	197.0			South Dakota	25.0			
Kansas	--	--	Oklahoma	2,170.3	Nebraska	1,404.1	Colorado	49.5	−216.8
					Missouri	933.5			
Minnesota	Iowa	334.2	Canada	256.9	North Dakota	5.4	Wisconsin	229.7	356.3
	South Dakota	0.4							
Missouri	Kansas	933.5	Arkansas	783.5	Iowa	197.0	Illinois	1,086.0	434.7
			Oklahoma	0.6					
Nebraska	Kansas	1,404.1	Wyoming	41.8	Iowa	1,205.6	--	--	238.8
			Colorado	9.2	South Dakota	10.8			
North Dakota	Minnesota	5.4	Montana	3.0	--	--	--	--	8.3
South Dakota	Iowa	25.0	--	--	Minnesota	0.4	Wyoming	0.5	34.8
	Nebraska	10.8	--	--	--	--	--	--	--
Total	--	4,116.0	--	3,265.3	--	4,116.0	--	2,059.0	[1]1,206.2
South Atlantic:									
Delaware	--	--	Pennsylvania	26.0	Maryland	2.0	--	--	24.0
Florida	Georgia	7.3	Alabama	280.0	--	--	--	--	287.3
Georgia	--	--	Alabama	1,400.7	South Carolina	1,044.7	Tennessee	12.3	336.4
	--	--	--	--	Florida	7.3	--	--	--
Maryland and District of Columbia	Virginia	866.2	--	--	--	--	Pennsylvania	669.5	212.1
	West Virginia	13.4	--	--	--	--	--	--	--
	Delaware	2.0	--	--	--	--	--	--	--
North Carolina	South Carolina	893.6	--	--	Virginia	725.4	--	--	168.3
South Carolina	Georgia	1,044.7	--	--	North Carolina	893.6	--	--	151.0
Virginia	North Carolina	725.4	Tennessee	8.5	Maryland	849.3	--	--	157.5
	West Virginia	289.8	--	--	District of Columbia	16.9	--	--	--
West Virginia	--	--	Kentucky	797.3	Virginia	289.8	Pennsylvania	789.4	1.1
	--	--	Ohio	296.4	Maryland	13.4	--	--	--
Total	--	3,842.4	--	2,808.9	--	3,842.4	--	1,471.2	1,337.7
East South Central:									
Alabama	Mississippi	3,267.0	--	--	Tennessee	1,305.0	Georgia	1,400.7	281.3
	--	--	--	--	--	--	Florida	280.0	--
Kentucky	Tennessee	3,967.3	--	--	--	--	Ohio	1,334.2	216.4
	--	--	--	--	--	--	Indiana	1,111.3	--
	--	--	--	--	--	--	West Virginia	797.3	--
	--	--	--	--	--	--	Illinois	508.1	--
Mississippi	--	--	Louisiana	4,671.1	Alabama	3,267.0	--	--	360.3
	--	--	Arkansas	1,898.0	Tennessee	2,941.8	--	--	--
Tennessee	Mississippi	2,941.8	Georgia	12.3	Kentucky	3,967.3	Virginia	8.5	283.3
	Alabama	1,305.0	--	--	--	--	--	--	--
Total	--	11,481.1	--	6,581.4	--	11,481.1	--	5,440.1	1,141.3

See footnotes at end of table.

Table 10.—Interstate pipeline movements of natural gas in the United States—Continued

(Billion cubic feet at 14.73 psia)

State and region	Receipts from				Deliveries to				Net receipts
	Within region		Outside region		Within region		Outside region		
	State	Quantity	State	Quantity	State	Quantity	State	Quantity	
West South Central:									
Arkansas	Louisiana	2,123.2	--	--	--	--	Mississippi	1,898.0	175.4
	Texas	609.9	--	--	--	--	Missouri	783.5	--
	Oklahoma	123.9	--	--	--	--	--	--	--
Louisiana	Texas	971.5	--	--	Arkansas	2,123.2	Mississippi	4,671.1	−5,822.8
Oklahoma	Texas	1,284.6	New Mexico	0.2	Arkansas	123.9	Kansas	2,170.3	−1,109.2
	--	--	--	--	--	--	Colorado	99.3	--
	--	--	--	--	--	--	Missouri	0.6	--
Texas	--	--	--	--	Oklahoma	1,284.6	New Mexico	874.2	−3,742.1
	--	--	--	--	Louisiana	971.5	Mexico	1.9	--
	--	--	--	--	Arkansas	609.9	--	--	--
Total	--	5,113.1	--	0.2	--	5,113.1	--	10,498.9	−10,498.7
Mountain:									
Arizona	New Mexico	1,689.6	--	--	Nevada	41.1	California	1,415.6	232.2
	Utah	3.8	--	--	--	--	Mexico	4.5	--
Colorado	Wyoming	115.1	Oklahoma	99.3	Utah	100.6	Nebraska	9.2	204.4
	New Mexico	50.3	Kansas	49.5	--	--	--	--	--
Idaho	Utah	60.8	Canada	434.8	Nevada	30.1	Washington	412.6	60.5
	--	--	Oregon	7.5	--	--	--	--	--
Montana	Wyoming	8.7	Canada	48.6	--	--	North Dakota	3.0	54.3
Nevada	Arizona	41.1	--	--	--	--	--	--	71.2
	Idaho	30.1	--	--	--	--	--	--	--
New Mexico	--	--	Texas	874.2	Arizona	1,689.6	Oklahoma	0.2	−865.9
	--	--	--	--	Colorado	50.3	--	--	--
Utah	Colorado	100.6	--	--	Arizona	3.8	--	--	101.3
	Wyoming	65.3	--	--	Idaho	60.8	--	--	--
Wyoming	--	--	South Dakota	0.5	Colorado	115.1	Nebraska	41.8	−230.4
	--	--	--	--	Utah	65.3	--	--	--
	--	--	--	--	Montana	8.7	--	--	--
Total	--	2,165.4	--	1,514.4	--	2,165.4	--	1,886.9	[1] −372.6
Pacific:									
Alaska	--	--	--	--	--	--	Japan	47.9	−47.9
California	Oregon	363.1	Arizona	1,415.6	--	--	--	--	1,778.6
Oregon	Washington	485.7	--	--	California	363.1	Idaho	7.5	115.1
Washington	--	--	Idaho	412.6	Oregon	485.7	--	--	182.4
	--	--	Canada	255.5	--	--	--	--	--
Total	--	848.8	--	2,083.7	--	848.8	--	55.4	[1] 2,028.3
Total United States	--	32,697.1	--	23,562.1	--	32,697.1	--	22,620.5	[1,2] 941.6

[1] Data may not add to totals shown because of independent rounding.
[2] Represents net imports of 993.9 billion cubic feet from Canada and 2.0 billion cubic feet from Algeria, and net exports of 47.9 billion cubic feet to Japan and 6.4 billion cubic feet to Mexico.

Table 11.—Summary of potential supply of natural gas in the United States (excluding Hawaii and island territories) as of December 31, 1972

(Trillion cubic feet at 14.73 psia and 60° F)

Supply area	Probable	Possible	Speculative	Total
	Area total—48 States			
Onshore (hole depth):				
0–15,000 ft	121	153	139	413
15,000–30,000 ft	33	45	59	137
Total	154	198	198	550
Offshore (water depth):				
0–600 ft	58	74	71	203
600–1,500 ft	[1] 1	18	9	27
Total	58	92	80	230
Grand total 48 States	212	290	278	780
	Area K—Alaska			
Total Alaska	54	94	218	366
Grand total 48 States and Alaska	266	384	496	1,146

[1] Less than 1 trillion cubic feet.

Table 12.—Estimated productive capacity of natural gas in the United States, December 31, 1972

(Million cubic feet per day at 14.73 psia at 60° F)

State	Productive capacity			State	Productive capacity		
	Non-associated	Associated-dissolved	Total		Non-associated	Associated-dissolved	Total
Alabama	19	8	27	New Mexico	2,566	1,197	3,763
Alaska	585	72	657	New York	12	--	12
Arkansas	735	53	788	North Dakota	2	103	105
California [1]	1,214	802	2,016	Ohio	242	48	290
Colorado	427	47	474	Oklahoma	6,730	1,976	8,706
Florida	--	64	64	Pennsylvania	222	2	224
Illinois	1	11	12	Texas [1]	23,434	7,751	31,185
Indiana	--	4	4	Utah	124	72	196
Kansas	6,740	192	6,932	Virginia	17	--	17
Kentucky	192	8	200	West Virginia	553	6	559
Louisiana [1]	23,775	3,838	27,613	Wyoming	940	390	1,330
Michigan	153	111	264	Other States [2]	10	2	12
Mississippi	265	59	324				
Montana	176	32	208	Total	69,144	16,854	85,998
Nebraska	10	6	16				

[1] Includes offshore productive capacity.
[2] Includes Arizona, Iowa, Maryland, Minnesota, Missouri, South Dakota, Tennessee, Washington.

Source: Committee on Natural Gas Reserves, American Gas Association.

Table 13.—Quantity and value of natural gas delivered

Region and State	Residential			Commercial		
	Number of consumers (thousands)	Quantity (million cubic feet) [3]	Value (thousands)	Number of consumers (thousands)	Quantity (million cubic feet) [3]	Value (thousands)
New England:						
Connecticut	370	32,879	$68,849	30	12,792	$22,207
Maine, New Hampshire, Vermont	79	6,036	12,920	6	3,583	5,929
Massachusetts	1,014	86,171	197,332	66	32,035	57,567
Rhode Island	153	13,294	27,293	10	4,060	7,645
Total	1,616	138,380	306,394	112	52,470	93,348
Middle Atlantic:						
New Jersey	1,626	149,924	302,547	177	60,114	90,472
New York	3,854	363,412	587,274	263	128,147	171,973
Pennsylvania	2,219	305,492	414,247	151	113,114	125,217
Total	7,699	818,828	1,304,068	591	301,375	387,662
East North Central:						
Illinois	2,872	487,845	553,704	216	218,160	185,436
Indiana	1,039	169,267	192,626	105	81,419	75,883
Michigan	1,970	355,266	390,082	170	152,874	139,268
Ohio	2,497	478,331	504,161	195	188,719	167,205
Wisconsin	774	104,648	140,019	65	40,914	42,264
Total	9,152	1,595,357	1,780,592	751	682,086	610,056
West North Central:						
Iowa	578	96,463	106,688	69	58,904	50,068
Kansas	614	100,720	74,130	59	54,940	29,173
Minnesota	623	107,119	131,863	57	55,637	52,354
Missouri	1,029	160,082	175,610	83	80,646	66,533
Nebraska	334	59,978	59,438	50	37,294	23,234
North Dakota	53	10,346	11,712	8	9,874	7,968
South Dakota	78	13,182	14,922	10	9,613	6,931
Total	3,309	547,890	574,363	336	306,908	236,261
South Atlantic:						
Delaware	79	8,358	14,292	5	3,205	4,343
Florida	345	12,837	34,121	29	18,981	25,966
Georgia	757	85,256	107,167	59	40,273	35,924
Maryland and District of Columbia	845	89,042	146,830	67	38,344	48,467
North Carolina	291	33,043	46,492	42	18,108	21,585
South Carolina	238	20,627	33,313	24	13,027	13,587
Virginia	471	55,427	88,572	45	27,037	32,390
West Virginia	361	59,523	57,380	32	23,792	17,820
Total	3,387	364,113	528,167	303	182,767	200,082
East South Central:						
Alabama	551	53,397	67,601	42	36,363	26,836
Kentucky	549	85,881	79,440	53	35,313	27,297
Mississippi	344	39,334	42,559	47	20,079	14,095
Tennessee	404	53,763	55,053	54	41,431	36,791
Total	1,848	232,375	244,653	196	133,186	105,019
West South Central:						
Arkansas	392	47,387	39,189	51	31,489	18,106
Louisiana	859	82,847	75,805	72	34,014	20,306
Oklahoma	650	77,608	69,692	68	39,637	22,633
Texas	2,698	240,662	244,031	243	94,036	58,961
Total	4,599	448,504	428,717	434	199,176	120,006

See footnotes at end of table.

to consumers in 1972, by type of consumer and by State

Industrial [1]		Electric utilities		Other consumers [2]		Total	
Quantity (million cubic feet) [3,4]	Value (thousands)	Quantity (million cubic feet) [3,5]	Value (thousands)	Quantity (million cubic feet) [3]	Value (thousands)	Quantity (million cubic feet) [3]	Value (thousands)
14,054	$16,485	30	$13	4,213	$5,338	63,968	$112,892
2,836	2,867	717	322	95	82	13,267	22,120
28,591	35,281	8,083	3,654	4,743	5,426	159,623	299,260
4,302	4,939	148	76	674	982	22,478	40,935
49,783	59,572	8,978	4,065	9,725	11,828	259,336	475,207
82,679	67,053	25,039	12,244	2,803	3,215	320,559	475,531
103,084	88,240	75,507	35,639	19,179	19,793	689,329	902,919
365,075	263,219	5,474	2,732	9,404	7,862	798,559	813,277
550,838	418,512	106,020	50,615	31,386	30,870	1,808,447	2,191,727
398,617	253,919	72,796	31,739	6,328	3,753	1,183,746	1,028,551
291,182	162,188	17,972	7,656	3,883	3,149	563,723	441,502
272,319	172,106	58,953	28,651	7,096	5,166	846,508	735,273
428,593	270,014	16,689	8,378	19,349	15,537	1,131,681	965,295
138,117	87,842	28,074	12,605	2,839	1,388	314,592	284,118
1,528,828	946,069	194,484	89,029	39,495	28,993	4,040,250	3,454,739
105,386	48,899	60,775	23,095	2,719	1,248	324,247	229,998
177,673	59,165	180,156	67,919	6,346	2,069	519,835	232,456
104,908	50,880	51,926	20,615	24,350	14,391	343,940	270,103
99,112	44,006	58,896	21,674	16,860	6,946	415,596	314,769
55,989	27,323	49,139	18,181	8,224	3,306	210,624	131,482
2,889	1,430	328	132	--	--	23,437	21,242
6,138	2,345	3,543	1,283	1,591	832	34,067	26,313
552,095	234,048	404,763	152,899	60,090	28,792	1,871,746	1,226,363
10,095	7,632	2,430	1,176	--	--	24,088	27,443
86,874	43,350	170,220	68,599	4,262	2,020	293,174	174,056
154,505	82,660	38,433	13,759	4,719	3,978	323,186	243,488
61,219	45,914	7,043	2,592	5,606	5,303	201,254	249,106
83,771	50,011	16,812	8,440	6,092	4,295	157,826	130,823
81,841	44,849	24,509	11,936	1,110	662	141,114	104,347
53,112	31,602	4,512	1,882	7,139	5,297	147,227	159,743
93,907	52,401	457	175	2,862	2,058	180,541	129,834
625,324	358,419	264,416	108,559	31,790	23,613	1,468,410	1,218,840
164,796	69,874	2,749	968	1,026	519	258,331	165,798
78,011	42,594	10,014	3,655	7,530	4,895	216,749	157,881
146,609	50,140	100,403	32,229	4,525	2,552	310,950	141,575
135,109	67,014	16,165	5,302	4,273	2,457	250,741	166,617
524,525	229,622	129,331	42,154	17,354	10,423	1,036,771	631,871
146,288	50,616	72,352	22,719	968	345	298,484	130,975
1,016,536	331,391	382,369	104,769	32,317	10,341	1,548,083	542,612
124,974	36,617	259,943	64,726	4,215	2,129	506,377	195,797
1,839,243	478,203	1,285,113	370,113	47,092	15,022	3,506,146	1,166,330
3,127,041	896,827	1,999,777	562,327	84,592	27,837	5,859,090	2,035,714

Table 13.—Quantity and value of natural gas delivered

Region and State	Residential			Commercial		
	Number of consumers (thousands)	Quantity (million cubic feet) [3]	Value (thousands)	Number of consumers (thousands)	Quantity (million cubic feet) [3]	Value (thousands)
Mountain:						
Arizona	465	34,259	42,618	41	22,891	17,122
Colorado	583	89,187	69,744	71	61,881	40,161
Idaho	81	10,887	16,407	11	8,838	9,854
Montana	143	23,787	22,978	18	16,521	11,416
Nevada	89	9,052	13,795	7	7,074	6,777
New Mexico	231	34,621	33,686	22	17,243	11,863
Utah	268	48,855	44,018	17	7,919	5,614
Wyoming	79	22,242	16,459	12	15,793	8,181
Total	1,939	272,890	259,705	199	158,160	110,988
Pacific:						
Alaska	21	8,394	13,036	3	9,106	9,871
California	5,818	637,289	687,635	368	224,103	184,437
Oregon	204	23,331	39,149	27	14,138	20,571
Washington	279	38,631	56,672	37	23,086	26,918
Total	6,322	707,645	796,492	435	270,433	241,797
Total United States	39,871	5,125,982	6,223,151	3,357	2,286,561	2,105,219

1 Includes refinery fuel use of 1,070,626 MMcf.
2 Includes deliveries to municipalities and public authorities for institutional heating, street lighting, etc.
3 Quantities in MMcf at 14.73 psia.
4 Includes 53,939 MMcf used for carbon black production.

5 Source: Federal Power Commission.

to consumers in 1972, by type of consumer and by State—Continued

Industrial [1]		Electric utilities		Other consumers [2]		Total	
Quantity (million cubic feet) [3] [4]	Value (thousands)	Quantity (million cubic feet) [3] [5]	Value (thousands)	Quantity (million cubic feet) [3]	Value (thousands)	Quantity (million cubic feet) [3]	Value (thousands)
63,089	30,030	77,715	32,563	4,014	2,332	201,968	124,665
82,763	27,395	66,929	20,614	1,273	528	302,033	158,442
30,309	16,246	--	--	1,874	1,179	51,908	43,686
33,192	12,679	1,218	418	2,630	1,273	77,348	48,764
7,672	5,485	40,043	18,860	5,681	3,431	69,522	48,348
76,768	25,871	59,141	21,823	15,111	5,153	202,884	98,396
60,758	22,116	3,718	1,208	14	10	121,264	72,966
54,968	16,545	2,857	860	1,494	433	97,354	42,478
409,519	156,367	251,621	96,346	32,091	14,339	1,124,281	637,745
12,328	8,432	13,085	5,666	6,905	3,218	49,818	40,223
623,479	293,659	605,790	242,316	7,433	3,702	2,098,094	1,411,749
62,167	33,881	408	184	392	243	100,436	94,028
101,169	47,752	--	--	168	94	163,054	131,436
799,143	383,724	619,283	248,166	14,898	7,257	2,411,402	1,677,436
8,167,096	3,683,160	3,978,673	1,354,160	321,421	183,952	19,879,733	13,549,642

Table 14.—Estimated total proved reserves of natural gas in the United States

(Million cubic feet at 14.73 psia at 60° F)

State	Reserves as of Dec. 31, 1971	Changes in reserves during 1972: Revisions	Extensions	New field discoveries	New reservoir discoveries in old fields	Net change in underground storage [1]	Production [2]	Reserves as of December 31, 1972: Total gas	Non-associated	Associated-dissolved	Underground storage [3]
Alabama	180,508	−10,010	4,852	75,406	--	--	5,042	245,714	227,909	17,805	--
Alaska	31,365,341	236,838	--	--	--	--	146,736	31,455,443	5,056,777	26,398,666	--
Arkansas	2,430,115	24,039	149,684	--	21,011	194	169,166	2,455,877	2,258,925	163,190	33,762
California [4]	5,729,499	−171,941	51,781	119,280	42,135	72,074	513,966	5,328,862	2,289,908	2,755,181	283,773
Colorado	1,818,323	−193,059	94,225	42,158	4,215	−730	109,932	1,655,200	1,458,215	174,012	22,973
Florida	178,659	2,013	8,091	6,266	--	--	14,400	180,629	--	180,629	--
Illinois	498,953	19,092	--	--	--	31,681	4,365	545,361	2,898	23,262	519,201
Indiana	86,678	3,410	--	--	--	−1,604	1,160	87,324	3,222	3,600	80,502
Kansas	12,535,198	−56,177	308,715	21,272	--	−3,820	866,472	11,938,716	11,602,586	245,720	90,410
Kentucky	956,292	1,742	28,276	3,198	5,225	6,997	63,648	938,082	747,241	46,158	144,683
Louisiana [4]	78,625,854	718,139	1,611,414	293,389	2,135,650	−694	8,412,418	74,971,334	61,550,914	13,247,854	172,566
Michigan	1,016,482	8,283	210,986	135,386	--	−35,165	39,157	1,296,815	293,938	385,580	617,297
Mississippi	1,117,432	−65,281	5,797	64,243	1,024	90,823	109,702	1,104,336	863,785	139,910	100,641
Montana	1,024,561	−30,867	97,719	3,978	1,020	−1,586	30,789	1,064,036	790,660	92,628	180,748
Nebraska	59,433	−13,687	676	1,683	--	6,556	4,401	50,260	16,909	7,547	25,804
New Mexico	13,067,954	16,953	378,016	45,259	3,652	−2,490	1,173,697	12,335,647	10,056,220	2,279,427	--
New York	139,092	3,600	7,275	800	350	−8,549	3,384	139,184	31,512	88	107,584
North Dakota	503,683	−34,727	2,448	7,140	--	--	36,919	441,625	10,422	431,203	--
Ohio	1,068,372	−1,800	171,961	20,000	--	−21,369	90,487	1,146,677	573,633	141,518	431,526
Oklahoma	15,712,818	−169,248	588,763	104,704	20,278	−8,973	1,756,312	14,492,030	11,494,770	2,767,400	229,860
Pennsylvania	1,395,931	416	89,125	2,500	1,800	−8,866	73,958	1,406,948	787,638	12,369	606,941
Texas [4]	101,472,108	−1,525,321	2,030,625	460,500	826,449	46,776	8,269,094	95,042,043	70,000,290	24,903,481	138,272
Utah	981,954	−64,259	123,093	27,093	--	92	45,863	1,022,110	561,711	458,732	1,667
Viriginia	31,075	--	7,200	400	--	--	2,754	35,921	35,921	--	--
West Virginia	2,411,784	−1,875	119,858	10,050	11,500	−17,126	188,234	2,345,957	1,916,685	53,672	375,600
Wyoming	4,131,492	227,707	62,203	17,434	21,523	7,107	378,738	4,088,728	3,422,904	610,830	54,994
Other States [5]	266,027	−1,771	900	400	300	5,235	1,104	269,987	17,050	950	251,987
Total	278,805,618	−1,077,791	6,153,683	1,462,539	3,096,132	156,563	22,511,898	266,084,846	186,072,643	75,541,412	4,470,791

[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.
[2] Preliminary net production.
[3] Gas held in underground reservoirs (including native and net injected gas) for storage purposes.
[4] Includes offshore reserves.
[5] Includes Arizona, Iowa, Maryland, Minnesota, Missouri, South Dakota, Tennessee, Washington.

Table 15.—Underground storage statistics, December 31, 1972

(Million cubic feet at 14.73 psia at 60° F)

State	Number of reservoirs	Type of reservoir: Dry gas	Oil and gas	Oil	Water	Other	Number of wells	Total gas in storage reservoirs (million cubic feet)	Total reservoir capacity (million cubic feet)
Arkansas	5	5	--	--	--	--	22	10,088	42,510
California	7	3	4	--	--	--	244	132,876	366,143
Colorado	6	4	1	--	--	[1] 1	57	14,363	29,040
Illinois	28	8	--	1	19	--	1,403	508,325	927,935
Indiana	27	16	--	--	11	--	859	63,547	153,709
Iowa	7	--	--	--	7	--	289	145,697	281,900
Kansas	16	16	--	--	--	--	743	76,151	106,584
Kentucky	21	15	2	--	4	--	1,082	67,962	200,717
Louisiana	5	5	--	--	--	--	107	140,413	223,860
Maryland	1	1	--	--	--	--	63	27,860	64,770
Michigan	33	30	1	1	--	[2] 1	2,415	376,619	781,383
Minnesota	1	--	--	--	1	--	38	3,951	20,000
Mississippi	4	3	--	--	--	[2] 1	69	71,694	108,956
Missouri	1	--	--	--	1	--	73	25,848	45,000
Montana	5	5	--	--	--	--	134	134,610	213,152
Nebraska	1	1	--	--	--	--	15	14,745	39,270
New Mexico	1	1	--	--	--	--	22	--	--
New York	17	17	--	--	--	--	730	92,808	134,788
Ohio	21	21	--	--	--	--	3,009	349,913	504,112
Oklahoma	11	10	1	--	--	--	191	208,426	317,413
Pennsylvania	68	68	--	--	--	--	2,128	574,132	763,183
Texas	17	6	5	6	--	--	180	72,785	175,995
Utah	1	--	--	--	1	--	8	1,667	1,679
Washington	1	--	--	--	1	--	58	16,175	17,649
West Virginia	35	33	2	--	--	--	1,167	350,903	436,742
Wyoming	8	7	--	--	1	--	23	41,495	83,243
Total	348	275	16	8	46	3	15,129	3,523,053	6,039,733

[1] Coal.
[2] Salt.

Source: American Gas Association.

Table 16.—Natural gas stored in and withdrawal statistics

(Million cubic feet at 14.73 psia)

State	1971 Total stored	1971 Total withdrawn	1971 Net stored	1972 Total stored	1972 Total withdrawn	1972 Net stored
Alabama	992	809	183	568	439	129
Arkansas	1,674	1,108	566	1,316	1,187	129
California	89,373	77,749	11,624	118,758	73,087	45,671
Colorado	5,839	6,433	−594	8,502	9,024	−522
Delaware	189	--	189	--	--	--
Illinois	214,871	127,279	87,592	237,098	197,188	39,910
Indiana	33,816	26,939	6,877	40,220	40,296	−76
Iowa	53,186	45,400	7,786	53,137	45,858	7,279
Kansas	49,267	49,083	184	46,810	48,391	−1,581
Kentucky	46,139	29,919	16,220	51,437	43,138	8,299
Louisiana	132,263	62,399	69,864	84,201	84,734	−533
Maryland	11,746	9,434	2,312	7,920	8,192	−272
Massachusetts	937	841	96	1,496	422	1,074
Michigan	296,475	289,599	6,876	275,460	306,491	−31,031
Mississippi	8,149	7,289	860	83,548	7,944	75,604
Missouri	11,741	10,296	1,445	10,188	8,692	1,496
Montana	18,668	11,864	6,804	8,801	7,281	1,520
Nebraska	5,982	2,356	3,626	8,837	2,282	6,555
New Jersey	1,626	1,469	157	1,765	1,785	−20
New York	48,026	40,607	7,419	32,777	42,894	−10,117
Ohio	188,916	168,833	20,083	163,884	185,454	−21,570
Oklahoma	66,666	45,698	20,968	59,061	66,852	−7,791
Pennsylvania	303,286	284,509	18,777	315,183	322,254	−7,071
Texas	36,850	34,452	2,398	87,251	47,269	39,982
Utah	883	728	155	906	691	215
Virginia	2,286	247	2,039	278	93	185
Washington	7,442	6,200	1,242	9,608	6,365	3,243
West Virginia	190,785	161,539	29,246	171,946	194,109	−22,163
Wyoming	11,325	4,551	6,774	11,996	4,806	7,190
Total	1,839,398	1,507,630	331,768	1,892,952	1,757,218	135,734

Table 17.—Quantity and value of marketed production of natural gas in the United States

State	1971			1972		
	Quantity (million cubic feet) [1]	Value (thousands)	Average wellhead value (cents per million cubic feet)	Quantity (million cubic feet) [1]	Value (thousands)	Average wellhead value (cents per million cubic feet)
Alabama	355	$54	15.1	3,644	$1,282	35.2
Alaska	121,618	r 17,878	r 14.7	125,596	18,463	14.7
Arizona	868	153	17.8	442	80	18.1
Arkansas	172,154	29,426	17.1	166,522	28,808	17,3
California	612,629	199,717	32.6	487,278	179,318	36.8
Colorado	108,537	16,932	15.6	116,949	1,930	16.5
Florida	903	270	29.9	15,521	4,967	32.0
Illinois	498	r 139	r 28.0	1,194	334	28.0
Indiana	537	r 89	r 16.5	355	55	15.5
Kansas	885,144	127,267	14.4	889,268	127,859	14.4
Kentucky	72,723	18,253	25.1	63,648	15,976	25.1
Louisiana	8,081,907	1,632,545	20.2	7,972,678	1,626,426	20.4
Maryland	214	r 43	r 20.0	244	51	20.9
Michigan	25,662	6,776	26.4	34,221	10,506	30.7
Mississippi	118,805	24,830	20.9	103,989	28,077	27.0
Missouri	22	5	24.8	9	2	24.9
Montana	32,720	3,959	12.1	33,474	4,117	12.3
Nebraska	3,496	612	17.5	3,478	619	17.8
New Mexico	1,167,577	175,137	15.0	1,216,061	225,420	18.5
New York	2,202	661	30.0	3,679	1,199	32.6
North Dakota	33,864	5,655	16.7	32,472	5,455	16.8
Ohio	79,903	27,007	33.8	89,995	35,271	39.2
Oklahoma	1,684,260	273,945	16.3	1,806,887	294,523	16.3
Pennsylvania	76,451	20,770	r 27.2	73,958	22,389	30.3
Tennessee	89	20	22.1	25	8	30.0
Texas	8,550,705	1,376,664	16.1	8,657,840	1,419,886	16.4
Utah	42,418	7,084	16.7	39,474	6,711	17.0
Virginia	2,619	822	31.4	2,787	892	32.0
West Virginia	234,027	60,613	25.9	214,951	64,485	30.0
Wyoming	380,105	58,156	15.3	375,059	60,760	16.2
Total	22,493,012	r 4,085,482	18.2	22,531,698	4,185,869	18.6

r Revised.

[1] Marketed production of 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 18.—Average wholesale prices for 14 large cities and adjacent areas

(Cents per Mcf)

Standard metropolitan statistical area	July 1, 1967	July 1, 1969	July 1, 1970	July 1, 1971	July 1, 1972 [1]
Baltimore	42.32	41.98	43.98	52.60	53.22
Boston	60.37	68.64	65.76	76.17	76.73
Chicago	30.03	29.63	31.93	36.04	36.65
Cleveland	42.76	40.50	44.64	49.09	52.90
Detroit	37.11	38.82	39.91	41.48	47.34
Los Angeles	31.24	31.60	34.63	38.78	40.74
Minneapolis	35.20	36.29	36.80	42.59	45.14
Newark	42.23	43.90	43.45	47.18	53.61
New York	41.51	41.52	42.51	45.98	51.93
Philadelphia	40.76	43.20	43.42	46.90	53.28
Pittsburgh	38.85	38.37	43.44	49.78	49.26
St. Louis	33.74	33.77	37.26	47.62	49.37
San Francisco	28.68	30.81	33.67	35.17	36.52
Washington, D.C	48.39	47.13	51.06	61.64	60.29

[1] Reflects contingent rates in effect subject to subsequent reduction and refund.

Source: Federal Power Commission.

Table 19.—Average price of residential heating gas by area 1965–1972

(Cents per 10 therms)

Standard metropolitan statistical area	January 1965	January 1966	January 1967	January 1968	January 1969	January 1970	January 1971	January 1972	January 1973
Atlanta	0.824	0.824	0.824	0.824	0.824	0.824	0.824	1.009	1.107
Baltimore	1.298	1.189	1.284	1.255	1.265	1.332	1.327	1.513	1.513
Boston	1.447	1.420	1.416	1.426	1.436	1.499	1.568	1.802	1.814
Buffalo	.896	.867	.878	.870	.905	.932	1.028	1.218	1.223
Chicago	.909	.926	.932	.944	.895	.965	1.021	1.110	1.130
Cincinnati	--	.764	.757	.771	.752	.799	.812	.943	.974
Cleveland	.735	.734	.736	.729	.732	.747	.858	.896	.938
Dallas	.725	.724	.727	.740	.755	.847	.849	.863	.890
Detroit	.855	.852	.850	.850	.850	.866	.873	.953	.998
Houston	--	.767	.767	.772	.871	.875	.928	.957	1.000
Kansas City	--	.582	.575	.569	.609	.681	.669	.717	.720
Milwaukee	--	1.067	1.067	1.067	1.101	1.247	1.272	1.350	.391
Minneapolis—St. Paul	--	.860	.823	.810	.851	.877	.913	.998	1.073
New York	1.361	1.362	1.305	1.290	1.299	1.320	1.363	1.568	1.660
Philadelphia	1.373	1.370	1.380	1.379	1.380	1.381	1.430	1.459	1.531
Pittsburgh	.758	.806	.796	.809	.845	.880	.970	1.018	1.064
St. Louis	.822	.839	.839	.838	.842	.916	.979	1.093	1.097
San Francisco—Oakland	.599	.599	.610	.608	.610	.622	.714	.762	.840
Seattle	.969	1.182	1.157	1.150	1.150	1.159	1.159	1.249	1.270
Washington, D.C	1.185	1.095	1.347	1.287	1.315	1.362	1.360	1.505	1.569
United States average	.820	.835	.831	.838	.844	.874	.920	1.010	1.047

Source: Bureau of Labor Statistics, Monthly release, "Retail Prices and Indexes of Fuels and Electricty" table 7; U.S. average, table 2.

Table 20.—Natural gas exports via pipeline: Volume, value, and unit cost, 1971–1972

Exporting companies	Point of entry	Gas volume (thousand cubic feet at 14.73 psia and 60° F) 1971	Gas volume 1972	% change	Value 1971	Value 1972	Average price (cents per thousand cubic feet) 1971	Average price 1972
EXPORTS TO CANADA								
Interstate company:								
Panhandle Eastern Pipe Line Co	Detroit River-River Rouge, Mich	14,235,679	15,426,455	8.4	6,327,878	7,745,752	44.45	50.21
Intrastate company:								
The Montana Power Company	Sweetgrass, Mont	112,963	126,223	11.7	42,590	47,420	37.70	37.57
Total Canada [1]		14,348,642	15,552,678	8.4	6,370,468	7,793,172	44.40	50.11
EXPORTS TO MEXICO								
Interstate company:								
El Paso Natural Gas Co	Naco, Ariz	4,659,338	4,521,863	[2] (3.0)	1,845,870	1,859,662	39.62	41.13
Intrastate companies:								
Del Norte Natural Gas Co	El Paso, Tex	3,765,693	2,719,557	[2] (27.8)	1,688,397	1,300,106	44.84	47.81
Texas Gas Utilities Co	Eagle Pass, Tex	1,858,323	1,825,244	(1.8)	554,775	608,017	29.85	33.31
Do	Laredo, Tex	4,423,680	4,281,604	(3.2)	1,066,809	1,078,047	24.12	25.18
United Gas, Inc	do	1,078,427	1,230,715	14.1	276,594	323,003	25.65	26.25
Total intrastate		11,126,123	10,057,120	[2] (9.6)	3,586,575	3,309,173	32.24	32.90
Total Mexico		15,785,461	14,578,983	[2] (7.6)	5,432,445	5,168,835	34.41	35.45
Grand total exports		30,134,103	30,131,661	[2] (.01)	11,802,913	12,962,007	39.17	43.02

[1] In addition Northern Natural Gas Company delivers natural gas produced from the Tiger Ridge Area, Montana (2,686 thousand Mcf) to Consolidated Natural Gas Company at a point on the Montana-Sasketchewan border for (transportation and) redelivery to Northern Montana on the Minnesota-Manitoba border near Emerson, Manitoba.
[2] Figures in parentheses denote decreases.

Source: FPC Form 14.

Table 21.—Natural gas imports via pipeline: Volume, value, and unit cost, 1971-1972

Importing companies	Point of entry	Gas volume (thousand cubic feet at 14.73 psia and 60° F) 1971	Gas volume 1972	% change	Value 1971	Value 1972	Average price (cents per thousand cubic feet) 1971	Average price 1972
IMPORTS FROM CANADA								
Interstate companies:								
El Paso Natural Gas Co	Sumas, Wash	189,134,499	255,495,902	35.1	51,587,768	83,209,904	27.28	32.57
Do	Eastport, Idaho	51,217,089	50,945,293	[1] (0.5)	12,961,023	16,511,124	25.31	32.40
Great Lakes Gas Transmission Co	Noyes, Minn	99,101,385	[2] 111,340,821	12.4	31,205,588	35,920,948	31.49	32.26
Michigan Wisconsin Pipe Line Co	do	18,250,000	18,300,000	0.3	5,866,606	6,142,350	32.15	33.56
Midwestern Gas Transmission Co	do	119,483,497	119,116,649	[1] (0.3)	35,617,678	35,927,358	29.81	30.16
Pacific Gas Transmission Co	Eastport, Idaho	354,001,740	383,890,217	8.4	89,958,676	110,351,466	25.41	28.75
Tennessee Gas Pipeline Co	Niagara Falls, N.Y	19,170,554	[3] 3,672,185	[1] (80.8)	8,417,655	1,912,841	43.91	52.09
Total interstate		850,358,764	942,761,067	10.9	235,614,994	289,975,991	27.71	30.76
Intrastate companies:								
ICG Transmission Ltd	Near Sprague, Manitoba (Canada)	7,152,989	[4] 8,098,257	13.2	3,329,708	3,595,042	46.55	44.39
The Montana Power Co	Whitlash, Mont	16,020,505	16,390,602	2.3	2,850,228	3,904,848	17.79	23.82
Do	Babb, Mont	28,627,116	32,198,571	12.5	6,541,137	7,383,204	22.85	22.93
The St. Lawrence Gas Co., Inc	Massena, N.Y	5,946,086	5,898,854	[1] (0.8)	3,312,039	3,417,141	55.70	57.93
Vermont Gas Systems, Inc	Highgate Falls, Vt	2,819,689	3,745,406	32.8	1,783,333	2,245,299	63.25	59.95
Total intrastate		60,566,385	66,331,690	9.5	17,816,445	20,545,534	29.41	30.97
Total Canada		910,925,149	1,009,092,757	10.8	253,431,439	310,521,525	27.82	30.77
IMPORTS FROM MEXICO								
Interstate company:								
Texas Eastern Transmission Corp	McAllen, Tex	20,651,695	8,109,658	[1] (60.7)	3,405,267	1,339,624	16.49	16.52
Intrastate company:								
City of Roma, Texas	Roma, Tex	37,706	30,884	[1] (18.1)	9,519	7,797	25.25	25.25
Total Mexico		20,689,401	8,140,542	[1] (60.7)	3,414,786	1,347,421	16.51	16.55
Grand total imports		931,614,550	1,017,233,299	9.2	256,846,225	311,868,946	27.57	30.66

[1] Figures in parentheses denote decreases.
[2] In addition to this amount 308,431,576 Mcf were received from Trans-Canada Pipe Lines Ltd. for transportation and 302,537,192 Mcf were redelivered to Trans-Canada at Sault, Ste. Marie, Mich.
[3] In addition to this amount 141,295 Mcf were received in exchange with Trans-Canada Pipe Lines Ltd. and 140,673 Mcf were delivered.
[4] In addition to this amount 11,510,811 Mcf were received from Trans-Canada Pipe Lines Ltd. for transportation and redelivery to Trans-Canada at Baudette, Minn.

Source: Federal Power Commission.

Table 22.—Natural gas: Production by country

(Million cubic feet)

Country [1]	1970		1971		1972 [p]	
	Gross production [2]	Marketed production [3]	Gross production [2]	Marketed production [3]	Gross production [2]	Marketed production [3]
North America:						
Barbados	[r] 117	97	129	106	[e] 130	[e] 110
Canada	[r] 2,625,927	[r] 2,277,109	2,825,904	2,499,024	3,316,058	2,913,645
Mexico	665,026	481,107	643,416	478,552	660,232	496,019
Trinidad and Tobago	120,699	66,687	109,814	65,074	[e] 107,000	[e] 70,000
United States	23,786,453	21,920,642	24,088,031	22,493,012	23,997,767	22,531,698
South America:						
Argentina	270,683	212,452	286,654	229,323	277,642	218,244
Bolivia	29,000	[e] 1,300	82,451	1,427	120,965	36,917
Brazil	44,638	[e] 8,000	41,566	[e] 8,300	43,861	[e] 8,500
Chile [4]	[r] 269,405	[r] 94,293	282,034	126,252	285,090	144,024
Colombia	104,894	46,736	111,288	51,186	115,622	60,988
Ecuador	10,176	[e] 500	9,620	[e] 500	5,328	[e] 500
Peru	74,818	16,822	67,227	16,935	64,430	17,164
Venezuela	1,710,200	348,630	1,680,252	368,230	1,625,196	387,723
Europe:						
Austria	67,027	66,992	66,790	64,293	69,327	65,459
Belgium [5]	[6] 1,865	1,865	[6] 1,780	1,780	[6] 1,695	1,695
Bulgaria	[r] [6] 16,723	[r] 16,723	[6] 11,560	11,560	[e] [6] 9,000	[e] 9,000
Czechoslovakia [7]	[r] [6] 42,519	[r] 42,519	[6] 43,190	43,190	[e] [6] 43,000	[e] 43,000
Denmark	--	--	--	--	993	(8)
France	[r] 361,974	242,964	380,690	252,463	385,761	265,452
Germany, East [e]	[6] 14,000	14,000	[6] 100,000	100,000	[6] 180,000	180,000
Germany, West [7]	[r] [9] 466,654	[r] [9] 459,822	[9] 562,779	[9] 555,194	645,111	635,549
Hungary [10]	[6] 122,506	122,506	[6] 131,123	131,123	[6] 144,295	144,295
Italy	[r] [6] 465,123	[r] 465,123	[6] 472,724	472,724	[6] 499,434	499,434
Netherlands	1,118,375	1,107,427	1,546,669	1,536,499	2,063,073	2,052,443
Norway	--	--	3,123	(8)	18,127	(8)
Poland [7]	[6] 183,014	183,014	[6] 190,094	190,094	[6] 205,640	205,640
Romania	[r] 883,957	[r] [11] 883,957	943,568	[11] 943,568	954,000	[11] 954,000
Spain	[6] 106	106	[6] 71	71	[e] [6] 85	[e] 85
U.S.S.R.	[e] 7,520,000	[r] 6,990,329	[e] 7,900,000	7,500,729	[e] 8,200,000	7,800,000
United Kingdom	[r] [6] 397,644	397,644	660,596	660,596	[6] 952,952	952,952
Africa:						
Algeria	[e] 340,000	[r] 100,223	[r] [e] 260,000	105,096	[e] 350,000	[e] 110,000
Angola	28,749	[e] 1,500	[r] [e] 27,000	[e] 1,500	31,393	[e] 2,000
Congo (Brazzaville)	[r] [6] 353	[r] 353	[6] 530	530	[e] [6] 535	[e] 535
Egypt, Arab Republic of [e]	37,000	3,000	31,000	3,000	23,000	2,500
Gabon	1,900	[r] 1,130	10,594	1,059	[e] 12,000	[e] 1,230
Libya	[r] 685,148	[e] 10,400	556,531	[e] 25,000	496,075	[e] 100,000
Morocco	[6] 1,539	1,539	1,680	1,608	1,822	1,763
Nigeria	285,804	3,920	446,840	6,509	458,169	3,946
Tunisia	316	[r] 177	327	35	[e] 1,000	699
Asia:						
Afghanistan [12]	[r] [6] 91,217	[r] 91,217	[6] 88,745	88,745	[e] [6] 90,000	[e] 90,000
Bahrain	25,406	12,305	25,364	17,902	[e] 25,000	[e] 18,000
Bangladesh	[6] 20,421	20,421	[6] 20,000	20,000	[6] 21,900	21,900
Brunei	126,654	7,965	[e] 120,000	[e] 8,000	[e] 170,000	[e] 11,000
Burma [13]	[r] 7,800	[r] [e] 2,000	[r] [e] 8,600	[r] 2,333	11,300	3,900
China, People's Republic of [e]	120,000	60,000	150,000	80,000	175,000	90,000
India	50,288	23,873	52,972	25,921	[e] 55,100	[e] 27,000
Indonesia	108,435	44,438	121,158	44,449	146,481	43,562
Iran	1,094,194	[r] 71,226	1,305,228	298,962	1,469,730	447,908
Iraq	[e] 200,000	27,720	[e] 220,000	30,722	[e] 185,000	[e] 30,000
Israel	[6] 4,753	4,753	[6] 4,378	4,378	[6] 4,386	4,386
Japan	83,311	82,682	85,936	85,156	87,406	86,320
Kuwait [14]	[r] 632,032	[r] 180,400	643,053	157,765	632,032	180,400
Malaysia (Sarawak)	[e] 6,500	2,698	[e] 25,000	2,297	[e] 35,000	3,325
Oman [e]	[r] 95,000	1,500	[r] 90,000	1,500	90,000	1,500
Pakistan	[r] [6] 113,435	[r] 113,435	[6] 107,680	107,680	[6] 118,680	118,680
Qatar	127,000	[e] 39,000	159,418	46,480	[e] 180,000	[e] 52,000
Saudi Arabia [14]	710,940	[r] 79,636	938,347	96,050	1,126,974	98,578
Syrian Arab Republic [e]	29,000	6,000	36,000	7,000	40,000	8,000
Taiwan	[r] 32,420	[r] 32,173	38,520	38,427	44,632	44,186
Turkey [e]	25,000	5,000	25,000	5,000	24,000	5,000
United Arab Emirates:						
Abu Dhabi	266,200	26,700	365,543	39,749	[e] 412,000	[e] 45,000
Dubai [e]	25,000	6,000	36,000	10,000	44,000	12,000

See footnotes at end of table.

Table 22.—Natural gas: Production by country—Continued

(Million cubic feet)

Country [1]	1970		1971		1972 p	
	Gross production [2]	Marketed production [3]	Gross production [2]	Marketed production [3]	Gross production [2]	Marketed production [3]
Oceania:						
Australia	[6] 53,061	53,061	[6] 79,049	79,049	[6] 112,581	112,581
New Zealand	[6] 3,769	3,769	10,627	8,592	12,484	e 9,000
Total	r 46,806,168	r 37,589,580	49,334,263	40,252,299	51,679,494	42,481,435

e Estimate. p Preliminary. r Revised.

[1] In addition to the countries listed, Albania, Cuba, Mongolia, and Thailand produce crude oil and presumably produced natural gas, but available information is inadequate to estimate output levels and the share of gross production that is a classifiable as marketed.

[2] Comprises all marketed production (see footnote 3) plus gas vented, flared, reinjected for repressuring and used to drive tubrines (without being burned).

[3] Comprises all gas collected and utilized as fuel or as a chemical industry raw material, including gas used in oil and/or gasfields as a fuel by producers, even though it is not actually sold.

[4] Apparently, natural gas that is vented or flared is not included in reported gross production; marketed output presented here is the difference between reported gross production and reported injected into reservoirs.

[5] Total production is obtained from coal mines.

[6] Gross production not reported; marketed output has been reported in lieu of a gross production estimate because the quantity flared, vented and/or reinjected is believed to be small.

[7] Includes output from coal mines as follows in million cubic feet: Czechoslovakia: 1970—11,442; 1971—12,290;1972—13,000 (estimate); West Germany; 1970—19,670; 1971—20,165; 1972—20,482 (estimate); Poland: 1970—7,310; 1971—7,734; 1972—7,950 (estimate); United Kingdom: 1970—5,686; 1971—4,838; 1972—4,600 (estimate).

[8] No marketed production reported; there probably is some small field use, but available information is inadequate to make reliable estimates.

[9] Revised to include output from coal mines, not previously included.

[10] Available statistics used for both gross and marketed production comprise marketed production plus gas used for repressuring, but exclude gas vented and/or flared. In 1968 (latest available figure), gas used for repressuring constituted only 0.4% of the total. Information is inadequate to make a reliable estimate of gas vented and/or flared, but it is believed to be small.

[11] Marketed production not reported; gross production (officially reported) has been used in lieu of a marketed production estimate because the quantity flared, vented and/or reinjected is believed to be small (less than 10%).

[12] Data are for year beginning March 21 of that stated.

[13] Data are for year ending June 30 of that stated.

[14] Includes ½ of production reported for the former Kuwait-Saudi Arabia Neutral Zone.

Natural Gas Liquids

By S. O. Wood, Jr.[1] and Leonard L. Fanelli [2]

Production of natural gas liquids from gas-processing plants increased to an alltime high of 638.2 million barrels. This production was 20.4 million barrels more than the 1971 output, an increase of 3.3%. Natural gas liquids production was valued at $1,452 million, 4.8% higher than the 1971 value of $1,386 million.

Natural gas liquids are products obtained from the processing of natural gas at natural gasoline plants, cycling plants, and fractionators. Included are ethane, the liquefied petroleum gases (LPG—butane, propane, and butane-propane mixtures), isobutane, mixed gases, natural gasoline, plant condensate, and finished products including gasoline, special naphthas, jet fuel, kerosine, distillate fuel oil, and miscellaneous finished products.

Continued demand for petrochemical feedstock and increased recovery capability contributed to the 20-million-barrel, 25%, increase in ethane production. Propane production increased 2.8% to 218.0 million barrels. Total butanes output increased 1.4% to 122.5 million barrels. Natural gasoline production was 156.5 million barrels, 2.1% less than in 1971. Isopentane output increased 30.3% to 7.2 million barrels. Plant condensate production decreased 14.5% to 22.0 million barrels.

Record high production contributed to an alltime natural gas liquids stock inventory of 108.9 million barrels at plants, including underground storage, in September 1972. The LPG portion of the stock inventory was 97.6 million barrels, compared with 92.0 million barrels in September 1971.

Earlier than usual cold weather, an unusually wet corn crop, and curtailment of natural gas deliveries precipitated a propane supply imbalance in some Midwestern States late in the year. By yearend propane futures for December 1973 delivery were 8 cents per gallon, about 40% higher than 4 months earlier.

The average unit value of natural gas liquids production was $2.28 per barrel, an increase of 1.8% from the comparable 1971 value. Unit values increased for all natural gas liquids components except the "Other products" category. LPG and ethane value increased 3.8% to $1.91 per barrel. Natural gasoline and isopentane value was $3.06 per barrel, an increase of 2.0% over the 1971 average. Plant condensate value increased 0.6% to $3.39 per barrel. Finished gasoline and naphtha unit value increased 7.4% to $4.66 per barrel. Other products average value declined 1.5% to $2.58 per barrel.

Data presented in this chapter were compiled from operating reports of natural gasoline plants, cycling plants, and fractionators that process natural gas. Included are all natural gas liquids except the small volume, considered to be insignificant in the national and State totals, recovered at pipeline compressor stations and gas dehydration plants. Plant condensate is included in natural gas liquids; field-separated condensate, however, is included with crude oil. Ethane and liquefied gases such as butane and propane, recovered from the crude oil refining operations, are classed as liquefied refinery gases (LRG) and reported as refinery products.

Annual reports were received from all large producers and distributors and from most of the dealers that sell more than 100,000 gallons of LPG per year. To reflect total shipments, the sample of dealer shipments was expanded by Petroleum Administration for Defense (PAD) districts on the basis of domestic demand in the districts.

Components of natural gas liquids used in this chapter are defined as follows:

Butane.—Includes all products covered by NGPA specifications for commercial bu-

[1] Petroleum engineer, Division of Fossil Fuels.
[2] Survey statistician, Division of Fossil Fuels.

tane, except those that contain 80% or more isobutane.

Butane-Propane Mix.—Includes all products covered by NGPA specifications for commercial butane-propane mixtures.

Distillate Fuel Oil.—Includes all light oil for shipment as fuel, including diesel fuel oil.

Ethane.—Includes ethane only. All other LPG mixed with ethane are reported in their respective product classification.

Gasoline.—Includes all products within the gasoline range for shipments as motor fuel.

Isobutane.—Includes all products covered by NGPA specifications for commercial butane, which contains 80% or more isobutane.

Isopentane.—Includes segregated isopentane.

Jet Fuel.—Includes all aviation turbine engine fuel for both military (JP–4 and JP–5) and commercial use.

Kerosine.—Includes all grades of kerosine or range oil.

Natural Gasoline.—A hydrocarbon mixture used primarily for blending or further processing into finished gasoline.

Other Products.—All products not otherwise classified.

Plant Condensate.—Includes those liquids, mostly pentanes and heavier, recovered and separated at raw natural gas inlet separators and scrubbers.

Propane.—Includes all products covered by the Natural Gas Processors Association (NGPA) specifications for commercial and HD–5 propane.

Special Naphtha.—Includes all hexanes and heptanes.

Production of natural gas liquids is reported by States; however, production for Louisiana and Texas is also reported by districts. Louisiana is divided into an Inland district and a Gulf Coast district. The Gulf Coast district includes Vernon, Rapides, Avoyelles, Pointe Coupee, West Feliciana, East Feliciana, Tangipahoa, St. Helena, and Washington Parishes and all parishes in the State south of these. All parishes not included in the Gulf Coast district are in the Inland district.

The Bureau of Mines producing districts in Texas correspond, with one exception, to groupings of Texas Railroad Commission districts:

Bureau of Mines districts	Railroad Commission districts
Gulf Coast	Nos. 2 and 3.
West Texas	Nos. 7C, 8 and 8A.
East Proper	Part of No. 6 (East Texas field in Cherokee, Smith, Upshur, Rusk, and Gregg Counties).
Panhandle	No. 10.
Rest of State:	
North	Nos. 7B and 9.
Central	No. 1
South	No. 4
Other East Texas	Nos. 5 and 6 (exclusive of East Proper).

The Bureau of Mines also groups refineries by geographical refining districts. These refining districts may be combined to correspond with the PAD districts, as follows:

PAD I.—*East Coast.*—District of Columbia, Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida, the following counties of New York: Cayuga, Tompkins, Chemung, and all counties east and north thereof, and the following counties of Pennsylvania: Bradford, Sullivan, Columbia, Montour, Northumberland, Dauphin, York, and all counties east thereof.

PAD I.—*Appalachian No. 1*—West Virginia and those parts of Pennsylvania and New York not included in the East Coast district.

PAD II.—*Appalachian No. 2*—The following counties of Ohio: Erie, Huron, Crawford, Marion, Delaware, Franklin, Pickaway, Ross, Pike, Scioto, and all counties east thereof.

PAD II.—*Indiana-Illinois-Kentucky*—Indiana, Illinois, Kentucky, Tennessee, Michigan, and that part of Ohio not included in the Appalachian district.

PAD II.—*Oklahoma-Kansas, Missouri*—Oklahoma, Kansas, Missouri, Nebraska, and Iowa.

PAD II.—*Minnesota-Wisconsin-North Dakota-South Dakota*—Minnesota, Wisconsin, North Dakota, and South Dakota.

PAD III.—*Texas Inland*—Texas, except Texas Gulf Coast district.

PAD III.—*Texas Gulf Coast*—The following counties of Texas: Newton, Orange, Jefferson, Jasper, Tyler, Hardin, Liberty, Chambers, Polk, San Jacinto, Montgomery, Galveston, Waller, Fort Bend, Brazoria, Wharton, Harris, Matagorda, Jackson, Victoria, Calhoun, Refugio, Aransas, San Patricio, Nueces, Kleberg, Kenedy, Willacy, and Cameron.

PAD III.—*Louisiana Gulf Coast*—The following parishes of Louisiana: Vernon, Rapides, Avoyelles, Pointe Coupee, West Feliciana, East Feliciana, Tangipahoa, St. Helena, Washington, and all parishes south thereof; the following counties of Mississippi: Pearl River, Stone, George Hancock, Harrison, and Jackson; and in Alabama: Mobile and Baldwin Counties.

PAD III.—*North Louisiana-Arkansas*—Arkansas and those parts of Louisiana, Mississippi, and Alabama not included in the Louisiana Gulf Coast District.

PAD III.—*New Mexico*—New Mexico.

PAD IV.—*Rocky Mountains*—Montana, Idaho, Wyoming, Utah, and Colorado.

PAD V.—*West Coast*—Washington, Oregon, California, Nevada, Alaska, Arizona, and Hawaii.

Some data in the chapter are based on the Bureau of Mines refining districts, and others refer to the PAD districts. Maps showing the PAD and Bureau of Mines refining districts appear in the Crude Petroleum and Petroleum Products chapter of this Minerals Yearbook volume.

DOMESTIC PRODUCTION

Domestic production of natural gas liquids totaled 638.2 million barrels, a 3.3% increase over that of 1971. Growth in the volume of ethane extraction was the principal contributor to the 20-million-barrel increase in natural gas liquids output in 1972.

Historic production of natural gas liquids and categories of principal components are shown in figure 1. Figure 2 illustrates the relative production of natural gas liquids principal components in 1972. LPG production increased 2.1% to 344.0 million barrels and accounted for 53.9% of

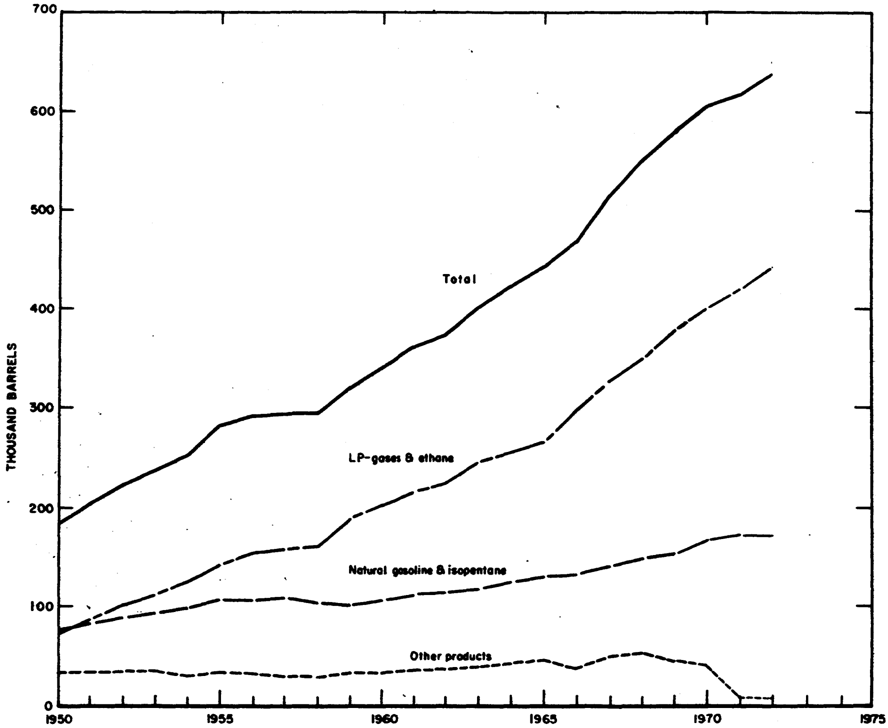

Figure 1.—Production of natural gas liquids in the United States.

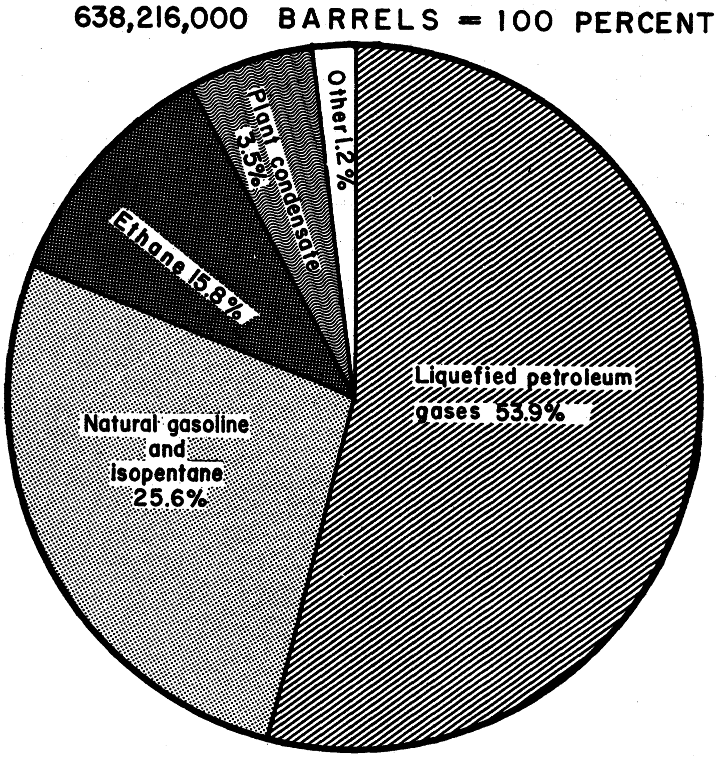

Figure 2.—The relative production of natural gas liquids components, 1972.

natural gas liquids output. Propane production was 218.0 million barrels, 2.8% higher than in 1971. Production of butanes (normal, other, and isobutane) aggregated 122.5 million barrels, 1.4% higher than in 1971. Natural gasoline and isopentane output totaled 163.7 million barrels, 1.0% less than comparable 1971 output. Ethane production of 100.7 million barrels was 15.8% of total natural gas liquids output. Production of plant condensate declined for the fourth consecutive year. Output of 22.0 million barrels was 14.5% less than in 1971.

Production of finished petroleum products at natural-gas-processing plants totaled 7,757,000 barrels. Motor gasoline accounted for 53.9% of the finished products, and other components included kerosine, 13.7%; distillate fuel oil, 15.7%; special naphthas, 3.4%; and miscellaneous products, 13.3%.

RESERVES

The American Gas Association, Inc. (AGA) Reserves Committee estimated that natural gas liquids proved reserves at year-end 1972 totaled 6,787 million barrels, a decline of 7%. This was the fifth consecutive year in which proved reserves have declined. According to AGA data, the yearend reserve to 1972 production ratio was 9.0:1, compared with 13.4:1 in 1967, when proved reserves were at an alltime high. Reserve additions from the discovery of new fields and new reservoirs totaled 87 million barrels. These additions were principally in Louisiana (41.1 million barrels), Texas (27.1 million barrels), and Alabama (9.6 million barrels). Texas accounted for 42.6%, and Louisiana accounted for 31.5% of the Nation's proved natural gas liquids reserves at yearend 1972. Although reserves estimates were higher in five of the 23 States reported, the overall change in reserves was a decrease of 517.7 million barrels.

PRODUCTIVE CAPACITY

According to the AGA, estimated productive capacity at yearend 1972 was 2,867,000 barrels per day, a decline of 155,000 barrels per day during the year. Increases in productive capacity were estimated for Kansas, up 60,000 barrels per day; Oklahoma, 22,000 barrels per day higher; and Michigan, up 1,000 barrels per day. Significant decreases were reported for Texas, Louisiana, and New Mexico. Respectively, decreases were 168,000, 26,000, and 17,000 barrels per day. Leading States and productive capacity in thousand barrels per day at yearend 1972 were Texas, 1,229; Louisiana, 884; Kansas, 228; Oklahoma, 204; and New Mexico, 168.

As natural gas liquids production is a function of natural gas production and processing, productive capacity is dependent upon rates of gas production from crude oil and natural gas reservoirs. The AGA has defined productive capacity of natural gas liquids as the amount of hydrocarbon liquids that would be produced coincident with the estimated productive capacity of natural gas based on unit recoveries at normal producing rates. Such estimated capacities are not limited by lack of capacity of processing plants or other surface facilities, and it is emphasized that adequate facilities would be required to effect the recovery of liquids from the natural gas produced at these rates. It should also be recognized that such facilities cannot be enlarged quickly. Therefore, the estimated natural gas liquid capacities, which relate to increased production of gas from oil and gas wells operating at their productive capacities, are theoretical and may not be realized in event of an emergency.[3] Although productive capacity estimates determined in accordance with the above definition are theoretical, they are useful in determining potential availability.

The long-term trend of annual increases in capacity of gas-processing plants ended. At yearend, daily capacity was 73.26 billion cubic feet, compared with 75.14 billion cubic feet at yearend 1971, according to The Oil and Gas Journal annual survey.[4] At yearend 1972 there were 786 gas-processing plants, 19 less than at the beginning of the year.

Increases in plant capacity were reported for Colorado, Kansas, Mississippi, Utah, and West Virginia. However, declines in other States resulted in a net decrease of 1.88 billion cubic feet per day in gas-processing capacity.

Texas and Louisiana continued as the leaders in number of plants and processing capacity. Combined, they had 501 plants, 64% of the U.S. total. Capacity of these plants was 52.30 billion cubic feet per day, 71% of the Nation's total.

CONSUMPTION AND USES

Input of natural gas plant products into refineries totaled 302.4 million barrels, an increase of 6.1% from the 1971 level. The increase resulted principally from a 36.3% larger volume of plant condensate input. Of the 53.2 million barrels of plant condensate input, 31.4 million barrels were

---

[3] American Gas Association, American Petroleum Institute, and Canadian Petroleum Association. Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas in the United States and Canada and United States Productive Capacity as of Dec. 31, 1971. V. 26, May 1972, p. 108.

[4] Cantrell, Aileen. 1973 Survey of Gas-Processing Plants. Oil and Gas J., v. 71, No. 28, July 9, 1973, p. 98.

imports, virtually all from Canada. LPG input to refineries increased from 79.7 million barrels in 1971 to 85.2 million barrels, a 6.9% change. Natural gasoline input to refineries decreased 2.4% to 156.9 million barrels. As indicated below, 51.9% of natural gas plant products input into refineries was natural gasoline. The following is a tabulation of natural gas plant product inputs into refineries in 1,000 barrels:

	1971	1972	% change
Condensate	39,020	53,190	+36.3
Isopentane	5,541	7,183	+29.6
LPG	79,695	85,193	+6.9
Natural gasoline	160,681	156,879	−2.4
Total	284,937	302,445	+6.1

Domestic demand for liquefied refinery gases (LRG) and LPG totaled 413.6 million barrels, 12.1% higher than the 1971 level. Of the 1972 domestic demand, 292.9 million barrels was for LPG produced at gas-processing plants, 84.0 million barrels was for LRG for fuel use, and 36.7 million barrels was for LRG for chemical use. Propane (including propylene) demand accounted for 326.8 million barrels, or 62.9%. Plant propane demand was 232.6 million barrels. Refinery propane and propylene demand was 94.2 million barrels of which 69.1 million barrels was for fuel use, and the remaining 25.1 million barrels was for chemical use.

Domestic demand for butane (including butylene) increased to 77.3 million barrels. Plant butane demand was 59.4 million barrels. Refinery butane and butylene demand totaled 17.9 million barrels, 12.2 million barrels for fuel use and 5.7 million barrels for chemical use.

Ethane (including ethylene) domestic demand increased significantly, 21.0%, to 106.2 million barrels. Virtually all ethane was used for petrochemical feedstocks. According to the U.S. Tariff Commission, preliminary production of ethylene, the principal market for ethane, increased 2 billion pounds to an alltime high of 20.5 billion pounds. For comparative purposes ethylene production was 5.9 billion pounds in 1960, and 18.5 billion pounds in both 1970 and 1971.

STOCKS

A record high stock inventory of 116.2 million barrels of natural gas liquids was attained September 30, 1972. Stocks at natural-gas-processing plants and terminals (including underground) were 108.9 million barrels, an increase of 9.6 million barrels over comparable stocks on September 30, 1971. Principal stock increases were in propane (8.7 million barrels) and ethane (3.8 million barrels). Stocks of normal butane decreased 3.2 million barrels.

At yearend 1972, total natural gas liquids stocks were 84.2 million barrels, 9.8 million barrels less than comparable stocks at yearend 1971. Natural gas liquids stocks at refineries were 5.0 million barrels at yearend 1972, a decrease of 0.6 million barrels from stocks at yearend 1971. Stocks at plants and terminals (including underground) totaled 79.2 million barrels, 9.2 million barrels less than comparable yearend 1971 stocks. By components, the major stock changes were for propane, down 12.5 million barrels; butane, down 4.1 million barrels; and ethane, up 3.7 million barrels.

PRICES AND VALUE

The average unit value of natural gas liquids was $2.28 per barrel, 1.8% higher than the 1971 average. At yearend propane futures prices had increased significantly, but factors such as alltime record high inventories, influence of long-term contracts, and price constraints set forth by the Federal Government contributed to the small increase in average value. Increases in average unit value for LPG and ethane were virtually nationwide, and total value increased 10.2% to $848 million. LPG and ethane total value accounted for 58.4% of natural gas liquids total value.

Unit value increases for natural gasoline and isopentane increased 2.0%; however, the total value of $500 million was less than an 0.8% increase because production declined. Natural gasoline and isopentane value was 34.5% of natural gas liquids total value.

Although plant condensate average unit value increased 2 cents to $3.39 per barrel, production decreased, and total value declined 14% to $75 million. Unit value of finished gasoline and naphtha increased 32 cents to $4.66 per barrel. Total value declined, however, as production declined 17%. Average unit value for other products decreased 1.5% to $2.58 per barrel.

FOREIGN TRADE

Plant condensate and LPG imports totaled 63.8 million barrels, an increase of 63.6% over that of 1971. The increase was attributed to a continuation of Oil Import Administration regulations that allowed natural gas liquids produced in the Western Hemisphere from Western Hemisphere crude and gas to be imported without being subject to quotas and also to the increasing gap between domestic production and demand.

Plant condensate imports increased from 13.3 million to 31.4 million barrels. Canada supplied 99.5% of plant condensate imports, and the remainder was from Venezuela. LPG imports increased from 25.7 million to 32.4 million barrels, a 26% increase. Canada provided 86% of LPG imports, and Venezuela supplied 12%. Leading suppliers of the remaining 2% ranked as follows: Saudi Arabia, Chile, Libya, Malaysia, Oman, Kuwait, and the United Kingdom.

The distribution pattern of natural gas liquids imports in thousand barrels was as follows:

PAD district	LPG	Plant condensate [1]	Total
I	5,336	798	6,134
II	14,441	16,478	30,919
III	787	--	787
IV	5,405	11,162	16,567
V	6,432	2,990	9,422
Total	32,401	31,428	63,829

[1] Includes natural gasoline.

According to Bureau of the Census data, LPG exports totaled 11.5 million barrels, a 22% increase over 1971 exports. Value of these exports totaled $46.6 million, an increase of 59%. Ninety percent of LPG exports were to Mexico, Japan received 7.7%, Canada received 1.0%, and the remaining 1.3% was distributed among more than 20 countries. LPG exports were comprised of butane, 7.2%; propane, 32.6%; and butane-propane mixtures, 60.2%.

WORLD REVIEW

Production data and sufficient information to make reliable estimates were not available for most nations. Among the reported larger worldwide projects that were approved or under construction were the following:

In Algeria the state-owned petroleum company, Société Nationale pour la Recherche, la Production, la Transport, la Transformation, et la Commercialization des Hydrocarbures (SONATRACH), was constructing two butane and propane units at the north and south sectors of the Hassi Messaoud oilfield. Combined capacity of the two units is 950,000 tons per year (11.2 million barrels). LPG output was scheduled to commence in March 1973.

Approval was granted by Argentina to Hydrocarbons Research, Inc., for constructing a 61,500-ton-per-year propane and butane plant in Santa Fe Province.

In Australia, Esso Standard Oil (Australia) Ltd. was constructing a gas treating and processing plant at Longford, Victoria.

One of the most active countries adding to its gas-processing capability was Canada. Included in the construction program were the following. Amoco Canada completed an 188-million-cubic-foot-per-day (MMcfd) plant at Pointed Mountain, Northwest Territories. At yearend the company was completing a 75-MMcfd plant at Ricinus, Alberta. The plant was designed to recover mixed LPG and pentanes plus heavier hydrocarbons by the refrigeration process. Aquitaine of Canada Ltd. completed an 180-MMcfd expansion of its Ram River plant. This expansion added 22,000 gallons per day of pentanes plus heavier hydrocarbons and also 2,000 long tons of sulfur per day capacity. Canadian Superior Oil Ltd. started an 162-MMcfd expansion at its

Harmattan, Alberta, plant. The refrigeration-absorption process is being used.

Iranian Oil Exploration Co. completed a 500-MMcfd gas-processing plant at Karanj, Iran. Expected natural gas liquids recovery is 10,200 barrels per day.

U.S.S.R. awarded a $24 million contract for engineering and supply of five natural gas drying and condensate-handling plants to the French firm ENSA. Construction started on these plants that were designed to treat 1.4 trillion cubic feet of gas per year from the Jamalo-Nenietzki fields. A 242-MMcfd fractionating plant is to be constructed at the Grosnij field by a French consortium headed by GEXA.

Naftagas Naftna Industrija completed an 100-MMcfd natural gas liquids plant at Mokrin, Yugoslavia.

Table 1.—Plant production, stocks at plants and terminals, shipments from plants of natural gas processing plant products in 1972

(Thousand barrels)

Product	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total 1972	Total 1971
Ethane:														
Production	7,467	7,788	8,633	7,802	8,274	7,958	8,680	8,687	8,535	9,060	8,720	9,087	100,691	80,524
Stocks	3,265	3,677	4,112	4,589	5,127	5,423	5,690	5,888	6,086	6,170	6,719	7,052	7,052	3,365
Shipments	7,567	7,376	8,198	7,325	7,736	7,662	8,413	8,489	8,337	8,976	8,171	8,754	97,004	78,478
Liquefied petroleum gases:														
Production	29,666	27,882	29,678	29,124	28,917	27,628	28,127	28,276	27,447	29,316	28,881	29,103	344,045	337,110
Stocks	68,551	59,576	59,629	65,214	74,609	82,590	89,688	93,454	97,637	94,198	83,473	67,807	67,807	80,294
Shipments	41,409	36,857	29,625	23,539	19,522	19,647	21,029	24,510	23,264	32,755	39,606	44,769	356,532	316,092
Isopentane:														
Production	627	572	597	599	594	635	610	620	618	649	563	567	7,251	5,565
Stocks	28	27	25	28	40	49	83	41	45	76	45	99	99	31
Shipments	630	573	599	596	582	626	576	662	614	618	594	513	7,183	5,541
Natural gasoline:														
Production	12,600	11,873	13,247	13,069	13,464	13,351	13,740	13,829	13,506	13,403	12,228	12,140	156,450	159,732
Stocks	3,608	3,750	3,833	3,912	3,925	3,662	3,742	3,795	3,897	3,553	3,442	3,285	3,285	3,647
Shipments	12,639	11,731	13,164	12,990	13,451	13,614	13,660	13,776	13,404	13,747	12,339	12,297	156,812	160,401
Plant condensate:														
Production	1,804	1,900	1,995	1,843	1,930	1,784	1,792	1,812	1,833	1,792	1,721	1,816	22,022	25,754
Stocks	706	726	692	805	776	738	742	837	828	834	800	763	763	594
Shipments	1,692	1,880	2,029	1,730	1,959	1,822	1,788	1,717	1,842	1,786	1,755	1,853	21,853	25,667
Motor gasoline:														
Production	356	344	356	339	344	364	395	366	329	328	327	334	4,182	5,023
Stocks	279	309	346	399	353	210	265	261	237	139	102	124	124	227
Shipments	304	314	319	286	390	507	340	370	353	426	364	312	4,285	4,994
Special naphthas:														
Production	24	20	24	22	22	21	22	22	20	23	21	23	264	329
Stocks	9	6	9	10	8	8	9	8	10	8	5	8	8	11
Shipments	26	23	21	21	24	21	21	23	18	25	24	20	267	327
Other products:														
Kerosine:														
Production	97	93	96	80	106	97	109	97	73	71	70	74	1,063	1,243
Stocks	195	94	80	91	97	97	92	71	60	64	35	43	43	201
Shipments	103	194	110	69	100	97	114	118	84	67	99	66	1,221	1,326
Distillate fuel oil:														
Production	108	98	107	107	107	112	101	104	99	95	86	96	1,220	1,370
Stocks	46	40	37	36	34	40	36	28	39	40	38	35	35	38
Shipments	100	104	110	108	109	106	105	112	88	94	88	99	1,223	1,390
Jet fuel:														
Production	--	--	--	--	--	--	--	--	--	--	--	--	--	9
Stocks	2	--	--	--	--	--	--	--	--	--	--	--	--	2
Shipments	--	2	--	--	--	--	--	--	--	--	--	--	2	10
Miscellaneous products:														
Production	296	270	284	275	297	287	302	284	245	254	249	268	3,311	3,778
Stocks	258	161	131	144	146	151	144	113	113	120	87	100	100	252
Shipments	290	367	314	262	295	282	309	315	245	247	282	255	3,463	3,886
Other products total:														
Production	676	634	664	636	663	672	719	672	594	605	597	625	7,757	9,130
Stocks	546	476	486	553	507	369	418	382	360	267	194	232	232	490
Shipments	620	704	654	569	709	810	670	708	616	698	670	587	8,015	9,207
All products, total:														
Production	52,840	50,649	54,814	53,073	53,842	52,028	53,668	53,896	52,533	54,825	52,710	53,338	638,216	617,815
Stocks	76,704	68,232	68,777	75,101	84,984	92,831	100,363	104,397	108,853	105,098	94,673	79,238	79,238	88,421
Shipments	64,557	59,121	54,269	46,749	43,959	44,181	46,136	49,862	48,077	58,580	63,135	68,773	647,399	595,386

Table 2.—Total production of products of natural gas processing plants, by State and month

(Thousand barrels)

State	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Arkansas	102	83	79	71	73	65	64	60	53	54	51	52	807
California and Alaska	1,280	1,233	1,321	1,262	1,281	1,246	1,292	1,295	1,220	1,222	1,175	1,086	14,913
Colorado	254	245	252	254	246	223	221	237	258	274	268	262	2,994
Florida, Pennsylvania, West Virginia	642	628	715	714	477	651	614	705	707	757	738	770	8,118
Illinois and Kentucky	786	1,028	1,081	1,061	1,100	1,050	1,038	1,145	1,078	1,182	1,120	1,038	12,707
Kansas	2,720	2,688	2,608	2,594	2,262	2,202	2,446	2,413	2,392	2,712	2,770	2,797	30,604
Louisiana	12,827	12,084	12,989	12,602	12,793	11,999	12,558	12,685	12,208	13,080	12,255	12,995	151,075
Michigan	111	89	99	95	97	93	110	111	108	108	102	105	1,228
Mississippi and Alabama	69	60	68	69	73	72	73	70	73	68	66	68	829
Montana and Utah	238	232	234	224	236	228	256	244	247	242	231	229	2,841
Nebraska and North Dakota	211	193	207	194	201	202	212	209	208	212	196	184	2,429
New Mexico	3,215	3,022	3,259	3,186	3,236	3,083	3,232	3,203	3,127	3,340	3,141	3,153	38,197
Oklahoma	3,561	3,405	3,672	3,524	3,591	3,467	3,411	3,473	3,258	3,482	3,450	3,413	41,707
Texas	25,870	24,772	27,302	26,346	27,283	26,618	27,296	27,251	26,704	27,136	26,201	26,282	319,061
Wyoming	954	887	928	877	893	829	845	795	892	956	946	904	10,706
Total United States	52,840	50,649	54,814	53,073	53,842	52,028	53,668	53,896	52,533	54,825	52,710	53,338	638,216

Table 3.—Production of natural gas liquids at natural gas processing plants and disposition of residue gas in the United States in 1971-72, by State

(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	Extraction loss (shrinkage)	Disposition of residue gas: Used at plants	Returned to formation	Vented or flared	Shipped to transmission companies	Direct deliveries to consumers	Unaccounted for	Total
1971:										
Arkansas	1,552	31,387	2,563	3,663	436	27	15,812	8,886	--	28,824
California and Alaska	17,865	431,605	27,684	24,512	193,284	r 4,894	123,825	r 52,498	4,908	403,921
Colorado	2,582	97,420	4,152	2,481	6,818	236	83,941	102	−310	93,268
Florida, Pennsylvania, West Virginia	7,938	146,318	11,174	3,899	28	--	129,495	1,722	--	135,144
Illinois and Kentucky	13,020	341,750	19,653	1,025	--	--	318,002	2,730	340	332,097
Kansas	28,602	1,451,438	39,741	7,755	1,509	63	1,343,300	59,384	−314	1,411,697
Louisiana	144,695	5,994,431	195,072	98,786	120,771	2,388	4,890,254	691,788	−4,628	5,799,359
Michigan	1,528	141,784	2,013	1,989	480	--	137,374	--	−72	139,771
Mississippi and Alabama	1,078	44,732	1,498	1,349	7,067	--	33,268	1,428	122	43,234
Montana and Utah	2,861	57,105	4,572	4,628	18,585	1,731	27,260	--	329	52,533
Nebraska and North Dakota	2,614	36,100	4,191	5,195	6,973	93	18,907	418	323	31,909
New Mexico	37,034	1,124,139	53,810	54,695	5,809	2,437	834,340	161,100	11,948	1,070,329
Oklahoma	41,737	1,123,614	55,914	48,313	86,190	401	819,797	110,680	2,319	1,067,700
Texas	306,721	7,938,550	448,288	305,216	894,667	20,738	5,487,688	754,698	27,255	7,490,262
Wyoming	7,988	292,434	12,802	9,481	12,387	108	246,743	12,162	−1,249	279,632
Total	617,815	19,252,807	883,127	572,987	1,355,004	r 33,116	14,510,006	r 1,857,596	40,971	18,369,680
1972:										
Arkansas	807	17,946	1,197	3,056	241	14	10,176	3,262	--	16,749
California and Alaska	14,913	386,664	24,905	22,240	201,614	7,028	91,175	35,771	3,931	361,759
Colorado	2,994	104,116	4,114	2,787	5,148	240	91,938	--	−111	100,002
Florida, Pennsylvania, West Virginia	8,118	326,092	11,625	4,119	22	--	309,466	797	63	314,467
Illinois and Kentucky	12,707	376,310	19,409	2,716	--	--	351,114	2,933	138	356,901
Kansas	30,604	1,497,319	40,738	9,268	1,884	82	1,374,268	71,362	−283	1,456,581
Louisiana	151,075	6,337,328	197,967	106,614	123,331	3,022	5,190,052	719,411	−3,069	6,139,361
Michigan	1,228	94,738	1,912	1,624	811	113	90,582	--	−304	92,826
Mississippi and Alabama	829	29,538	1,301	1,426	4,837	--	21,116	826	32	28,237
Montana and Utah	2,841	61,757	4,221	4,371	19,867	1,076	31,718	--	504	57,536
Nebraska and North Dakota	2,429	35,021	3,738	4,174	6,849	83	19,905	85	187	31,283
New Mexico	38,197	1,126,192	54,157	53,218	5,528	2,714	856,568	146,671	7,336	1,072,035
Oklahoma	41,707	1,116,872	56,376	45,604	76,872	207	842,165	92,869	2,779	1,060,496
Texas	319,061	8,139,408	470,105	317,136	931,461	9,825	5,566,168	811,374	33,339	7,669,303
Wyoming	10,706	298,439	16,228	9,692	13,636	566	248,432	9,407	478	282,211
Total	638,216	19,947,740	907,993	588,045	1,392,101	24,970	15,094,843	1,894,768	45,020	19,039,747

r Revised.

Table 4.—Natural gas liquids production and value at natural gas processing plants, by State and product

State	Number of operating companies [1]	LPG and ethane: Quantity (thousand barrels)	LPG and ethane: Value (thousands)	LPG and ethane: Dollars per barrel [2]	Natural gasoline and isopentane: Quantity (thousand barrels)	Natural gasoline and isopentane: Value (thousands)	Natural gasoline and isopentane: Dollars per barrel [2]	Plant condensate: Quantity (thousand barrels)	Plant condensate: Value (thousands)	Plant condensate: Dollars per barrel [2]
Arkansas	3	546	$1,420	$2.60	231	$758	$3.28	--	--	--
California and Alaska	19	5,851	15,979	2.73	8,533	28,524	3.34	529	$2,021	$3.82
Colorado	9	1,749	3,673	2.10	1,245	3,349	2.69	--	--	--
Florida, Pennsylvania, West Virginia	6	6,498	13,176	2.03	1,061	3,365	3.17	559	1,571	2.81
Illinois and Kentucky	3	12,118	27,266	2.25	577	1,919	3.33	12	43	3.56
Kansas	14	25,099	43,170	1.72	5,482	13,102	2.39	20	60	2.98
Louisiana	38	98,233	185,660	1.89	42,088	127,106	3.02	4,893	17,859	3.65
Michigan	5	833	2,274	2.73	387	1,072	2.77	4	14	3.40
Mississippi and Alabama	6	413	1,024	2.48	342	1,071	3.13	70	235	3.36
Montana and Utah	6	2,184	3,790	1.74	654	2,049	3.13	3	10	3.45
Nebraska and North Dakota	5	1,890	3,823	2.02	537	1,562	2.91	2	7	3.50
New Mexico	11	27,859	45,689	1.64	10,045	29,131	2.90	250	745	2.98
Oklahoma	35	27,148	57,011	2.10	13,399	38,857	2.90	1,042	3,501	3.36
Texas	72	226,624	428,319	1.89	76,445	240,802	3.15	14,298	47,469	3.32
Wyoming	17	7,691	15,536	2.02	2,675	7,758	2.90	340	1,193	3.51
Total	131	444,736	847,810	1.91	163,701	500,425	3.06	22,022	74,728	3.39

State	Number of operating companies [1]	Finished gasoline and naphtha: Quantity (thousand barrels)	Finished gasoline and naphtha: Value (thousands)	Finished gasoline and naphtha: Dollars per barrel [2]	Other products [3]: Quantity (thousand barrels)	Other products [3]: Value (thousands)	Other products [3]: Dollars per barrel [1]	Total: Quantity (thousand barrels)	Total: Value (thousands)	Total: Dollars per barrel [2]
Arkansas	3	--	--	--	30	$96	$3.19	807	$2,274	$2.82
California and Alaska	19	--	--	--	--	--	--	14,913	46,524	3.12
Colorado	9	--	--	--	--	--	--	2,994	7,022	2.35
Florida, Pennsylvania, West Virginia	6	--	--	--	--	--	--	8,118	18,112	2.23
Illinois and Kentucky	3	--	--	--	--	--	--	12,707	29,228	2.30
Kansas	14	--	--	--	3	8	2.52	30,604	56,340	1.84
Louisiana	38	3,501	$16,455	$4.70	2,360	6,348	2.69	151,075	353,428	2.34
Michigan	5	--	--	--	4	11	2.68	1,228	3,371	2.75
Mississippi and Alabama	6	--	--	--	4	15	3.78	829	2,345	2.83
Montana and Utah	6	--	--	--	--	--	--	2,841	5,849	2.06
Nebraska and North Dakota	5	--	--	--	--	--	--	2,429	5,392	2.22
New Mexico	11	--	--	--	43	94	2.18	38,197	75,659	1.98
Oklahoma	35	13	51	3.91	105	300	2.86	41,707	99,720	2.39
Texas	72	932	4,231	4.54	762	1,661	2.18	319,061	722,482	2.26
Wyoming	17	--	--	--	--	--	--	10,706	24,487	2.29
Total	131	4,446	20,737	4.66	3,311	8,533	2.58	638,216	1,452,233	2.28

[1] A producer operating in more than one State is counted only once in arriving at U.S. total.
[2] Represents average unit value of sales throughout the year.
[3] Includes kerosine, distillate fuel oil, and miscellaneous products.

Source: Company reports and Bureau of Mines estimates.

Table 5.—Natural gas liquids production at natural gas processing plants, by product and PAD district

(Thousand barrels)

PAD Districts and States	Ethane	Liquefied petroleum gases: Propane	Normal butane	Other butanes	Butane-propane mixture	Isobutane	Total	Natural gasoline and isopentane	Plant condensate	Finished gasoline and naphtha	All other products [1]	Total
District I	(2)	3,159	738	600	--	289	4,786	(2)	559	--	--	8,118
District II												
Michigan	--	523	52	181	65	12	833	387	4	--	4	1,228
Kansas	2,995	15,746	3,661	1,281	1	1,415	22,104	5,482	20	--	3	30,604
Nebraska	--	198	121	--	--	--	319	97	--	--	--	416
North Dakota	--	964	558	49	--	--	1,571	440	2	--	--	2,013
Oklahoma	542	17,530	4,934	2,628	31	1,483	26,606	13,399	1,042	13	105	41,707
Other States [3]	[2] 8,944	3,871	615	--	--	400	4,886	[2] 1,638	12	--	--	[2] 12,707
Total District II	[2] 12,481	38,832	9,941	4,139	97	3,310	56,319	[2] 21,443	1,080	13	112	[2] 88,675
District III												
Alabama and Mississippi	--	170	126	--	117	--	413	342	70	--	4	829
Arkansas	--	311	147	--	--	88	546	231	--	--	30	807
Louisiana:												
Gulf	27,538	39,156	12,614	710	97	12,838	65,415	40,684	4,210	1,638	1,364	140,849
Inland	817	2,429	973	187	204	670	4,463	1,404	683	1,863	996	10,226
Total Louisiana	28,355	41,585	13,587	897	301	13,508	69,878	42,088	4,893	3,501	2,360	151,075
New Mexico	3,035	14,043	4,558	4,396	157	1,670	24,824	10,045	250	--	43	38,197
Texas:												
Gulf	16,520	15,071	5,107	649	789	4,339	25,955	16,502	2,095	205	153	61,430
West	24,141	46,904	11,227	5,511	209	2,608	66,459	22,097	3,516	--	8	116,221
East (field)	402	3,188	1,714	646	26	395	5,969	2,022	24	--	31	8,448
Panhandle	844	14,595	3,240	7,340	27	1,690	26,892	11,637	31	--	15	39,419
Other	14,873	28,382	7,580	2,184	1,612	4,811	44,569	24,187	8,632	727	555	93,543
Total Texas	56,780	108,140	28,868	16,330	2,663	13,843	169,844	76,445	14,298	932	762	319,061
Total District III	88,170	164,249	47,286	21,623	3,238	29,109	265,505	129,151	19,511	4,433	3,199	509,969
District IV												
Colorado	--	1,120	44	585	--	--	1,749	1,245	--	--	--	2,994
Montana and Utah	--	1,317	766	20	--	81	2,184	654	3	--	--	2,841
Wyoming	40	4,665	1,359	1,409	--	218	7,651	2,675	340	--	--	10,706
Total District IV	40	7,102	2,169	2,014	--	299	11,584	4,574	343	--	--	16,541
District V	--	4,697	364	50	200	540	5,851	8,533	529	--	--	14,913
Total United States	100,691	218,039	60,498	28,426	3,535	33,547	344,045	163,701	22,022	4,446	3,311	638,216

[1] Includes jet fuel, kerosine, distillate, and other.
[2] PAD district I data included with PAD district II, Other States.
[3] Other States includes Florida, Illinois, Kentucky, Pennsylvania, and West Virginia for ethane, natural gasoline, and isopentane only.

Table 6.—Production of natural gasoline by vapor pressure and PAD district in the United States, 1972

(Thousand barrels)

Reid vapor pressure	District I	District II	District III	District IV	District V	Total
12 pounds and less	269	2,589	59,681	1,649	856	65,044
Over 12 pounds including 14 pounds	775	6,155	16,232	890	49	24,101
Over 14 pounds including 18 pounds	--	4,797	8,575	795	232	14,399
Over 18 pounds including 22 pounds	17	361	1,018	51	1,488	2,935
Over 22 pounds including 26 pounds	--	1,364	13,758	204	1,186	16,512
Over 26 pounds	--	4,871	23,012	854	4,722	33,459
Total	1,061	20,137	122,276	4,443	8,533	156,450

Table 7.—Comparison of 1971 and 1972 natural gas liquids production and value

	Thousand barrels		% change	Thousand dollars		% change	Dollars per barrel		% change
	1971	1972		1971	1972		1971	1972	
LPG and ethane	417,634	444,736	+6.5	769,397	847,810	+10.2	1.84	1.91	+3.8
Natural gasoline and isopentane	165,297	163,701	−1.0	496,676	500,425	+.8	3.00	3.06	+2.0
Plant condensate	25,754	22,022	−14.5	86,870	74,728	−14.0	3.37	3.39	+.6
Finished gasoline and naphthas	5,352	4,446	−16.9	23,210	20,737	−10.7	4.34	4.66	+7.4
Other products	3,778	3,311	−12.4	9,901	8,533	−13.8	2.62	2.58	−1.5
Total or average	617,815	638,216	+3.3	1,386,054	1,452,233	+4.8	2.24	2.28	+1.8

Table 8.—Estimated proved recoverable reserves of natural gas liquids[1] in the United States

(Thousand barrels)

State	Reserves Dec. 31, 1971	Changes in reserves in 1972		Reserves Dec. 31, 1972			
		Extensions and revisions	Discoveries, new fields and reservoirs	Non-associated	Associated dissolved	Total	Change from Dec. 31, 1971
Alabama	24,197	−5,755	9,588	26,841	765	27,606	+3,409
Alaska	454	--	--	--	442	442	−12
Arkansas	9,619	−358	--	5,383	2,395	7,778	−1,841
California [2]	151,091	−10,056	--	3,606	123,120	126,726	−24,365
Colorado	26,231	−8,215	235	9,916	6,163	16,079	−10,152
Florida	11,265	−2,375	--	--	8,800	8,800	−2,465
Illinois	942	+40	--	--	814	814	−128
Indiana	27	−8	--	--	14	14	−13
Kansas	276,593	+144,526	706	382,885	10,197	393,082	+116,489
Kentucky	47,118	+2,267	602	46,782	--	46,782	−336
Louisiana [2]	2,467,880	−124,740	41,065	1,793,986	341,851	2,135,837	−332,043
Michigan	12,584	+3,747	3,791	5,531	13,495	19,026	+6,442
Mississippi	14,933	+889	473	7,411	7,209	14,620	−313
Montana	9,081	−3,975	--	925	3,488	4,413	−4,668
Nebraska	1,419	+637	--	707	923	1,630	+211
New Mexico	550,026	+4,596	377	317,645	185,142	502,787	−47,239
North Dakota	47,128	--	90	90	45,277	45,367	−1,761
Oklahoma	338,353	+36,022	2,586	237,749	97,412	335,161	−3,192
Pennsylvania	817	--	--	735	--	735	−82
Texas [2]	3,100,617	+100,375	27,093	1,603,194	1,288,389	2,891,583	−209,034
Utah	33,947	+2,118	--	714	33,288	34,002	+55
West Virginia	82,263	+5,435	--	82,084	--	82,084	−179
Wyoming	97,642	+6,163	334	46,537	44,654	91,191	−6,451
Total	7,304,227	+151,333	86,940	4,572,721	2,213,838	6,786,559	−517,668

[1] Natural gasoline, liquefied petroleum gases, and condensate.
[2] Includes offshore. Remaining proved natural gas liquids reserves in the Gulf of Mexico estimated to be 872,491,000 barrels.

Source: American Gas Association.

Table 9.—Estimated productive capacity of natural gas liquids in the United States [1]

(Thousand barrels per day)

	Productive capacity		
	Non-associated	Associated—dissolved	Total
Alabama	1	1	2
Arkansas	3	2	5
California [2]	1	49	50
Colorado	4	4	8
Florida	--	1	1
Kansas	222	6	228
Kentucky	6	--	6
Louisiana [2]	772	112	884
Michigan	3	4	7
Mississippi	3	2	5
Montana	1	1	2
Nebraska	1	1	2
New Mexico	71	97	168
North Dakota	--	5	5
Oklahoma	135	69	204
Texas [2]	669	560	1,229
Utah	1	6	7
West Virginia	15	--	15
Wyoming	17	22	39
Miscellaneous [3]	--	--	--
Total	1,925	942	2,867

[1] During the heating season immediately following Dec. 31, 1972.
[2] Includes offshore.
[3] Includes Alaska, Arizona, Illinois, Indiana, Iowa, Maryland, Minnesota, Missouri, New York, Ohio, Pennsylvania, South Dakota, Tennessee, Virginia, and Washington.

Source: Committee on Natural Gas Reserves, American Gas Association.

Table 10.—Production, stocks, and demand of liquefied gases and ethane at gas-processing plants and refineries

(Thousand barrels)

	Ethane	Propane	Butane	Butane-propane mixtures	Isobutane	Total
Production:						
At gas-processing plants	100,691	218,039	88,924	3,535	33,547	444,736
At refineries:						
For fuel use	--	69,038	12,940	2,536	--	84,514
For chemical use	9,197	25,024	5,673	3,892	2,079	45,865
Total	109,888	312,101	107,537	9,963	35,626	575,115
Net change in stocks:						
Liquefied petroleum gases:						
At gas-processing plants	3,687	−8,560	−3,182	129	−874	−8,800
At refineries	--	−579	−189	−7	159	−616
Liquefied refinery gases:						
For fuel use	--	−91	713	−127	--	495
For chemical use	--	−70	4	−1	−8	−75
Exports	--	6,502	4,967	--	--	11,469
Imports	--	15,851	16,550	--	--	32,401
Used at refineries	--	3,934	44,512	2,485	34,262	85,193
Domestic demand:						
At gas-processing plants	97,004	232,593	59,366	928	--	389,891
At refineries:						
For fuel use	--	69,129	12,227	2,663	--	84,019
For chemical use	9,197	25,094	5,669	3,893	2,087	45,940
Total	106,201	326,816	77,262	7,484	2,087	519,850
Yearend stocks:						
Liquefied petroleum gases:						
At gas-processing plants	7,052	48,219	10,389	944	8,255	74,859
At refineries	--	190	1,425	31	1,431	3,077
Liquefied refinery gases:						
For fuel use	--	4,959	2,161	367	--	7,487
For chemical use	--	193	15	2	84	294
Total	7,052	53,561	13,990	1,344	9,770	85,717

Table 11.—Natural gas liquids [1] used as refinery input in the United States in 1972, by Bureau of Mines refinery district, and by month

(Thousand barrels)

District	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
East Coast	286	147	290	92	118	163	175	96	92	61	41	66	1,627
Appalachian	5	33	60	75	90	84	209	195	219	172	175	217	1,534
Indiana, Illinois, Kentucky	2,669	2,572	2,855	1,927	2,137	2,135	2,671	2,658	2,704	2,952	3,772	3,357	32,409
Minnesota, Wisconsin, North Dakota, South Dakota	700	689	820	704	794	886	1,035	1,128	1,194	1,217	1,238	1,231	11,636
Oklahoma, Kansas, Missouri	1,945	1,931	1,777	1,602	1,536	1,670	1,757	1,830	1,889	2,293	2,160	2,134	22,524
Texas:													
Inland	2,054	1,766	2,019	1,955	2,061	2,150	2,286	2,244	2,175	2,227	2,067	2,180	25,184
Gulf Coast	10,300	9,123	10,099	10,226	10,859	9,693	9,782	9,399	10,140	10,677	9,805	9,441	119,544
Total	12,354	10,889	12,118	12,181	12,920	11,843	12,068	11,643	12,315	12,904	11,872	11,621	144,728
Louisiana-Arkansas:													
Louisiana Gulf Coast	4,169	4,660	3,639	3,482	3,371	3,548	3,514	3,267	3,234	3,682	4,337	4,363	45,266
North Louisiana-Arkansas	312	304	360	356	383	336	339	324	352	363	377	472	4,278
Total	4,481	4,964	3,999	3,838	3,754	3,884	3,853	3,591	3,586	4,045	4,714	4,835	49,544
New Mexico	82	91	96	68	90	104	98	101	132	133	128	109	1,227
Other Rocky Mountain	1,388	1,370	1,375	1,296	1,185	1,269	1,183	1,411	1,394	1,282	1,539	1,559	16,251
West Coast	1,893	1,719	1,751	1,468	1,889	1,818	1,573	1,868	1,513	1,889	1,875	1,709	20,965
Total United States	25,803	24,405	25,141	23,251	24,513	23,856	24,622	24,521	25,038	26,948	27,509	26,838	302,445

[1] Comprised of plant condensate (including imports), natural gasoline, LPG, and isopentane.

Table 12.—Liquefied refinery gases and ethane produced at refineries for fuel and chemical use in 1972

(Thousand barrels)

PAD districts and States	Ethane	Propane	Butane	Butane-propane mixture	Total
District I:					
New Jersey	--	5,473	1,245	106	6,824
Pennsylvania	--	7,047	111	--	7,158
Other States [1]	--	3,810	122	6	3,938
Total District I	--	16,330	1,478	112	17,920
District II:					
Illinois	--	7,771	159	--	7,930
Indiana	--	978	287	--	1,265
Kansas	590	3,905	105	--	4,600
Kentucky	--	1,091	151	--	1,242
Michigan	--	1,604	110	5	1,719
Ohio	--	5,007	--	--	5,007
Oklahoma	--	3,256	255	163	3,674
Other States [2]	--	1,962	112	222	2,296
Total District II	590	25,574	1,179	390	27,733
District III:					
Alabama and Mississippi	--	2,048	6	64	2,118
Arkansas	--	167	48	--	215
Louisiana:					
Gulf	3,147	14,646	2,259	2,788	22,840
Inland	--	73	109	151	333
Total Louisiana	3,147	14,719	2,368	2,939	23,173
New Mexico	--	216	243	--	459
Texas:					
Gulf	4,802	20,945	9,384	616	35,747
West	104	1,232	502	7	1,845
East	--	246	--	--	246
Panhandle	--	1,017	417	--	1,434
Other	--	120	37	--	157
Total Texas	4,906	23,560	10,340	623	39,429
Total District III	8,053	40,710	13,005	3,626	65,394
District IV:					
Colorado	--	126	303	--	429
Montana	--	629	51	--	680
Utah	--	548	11	6	565
Wyoming	3	208	191	175	577
Total District IV	3	1,511	556	181	2,251
District V	551	9,937	4,474	2,119	17,081
Total United States	9,197	94,062	[3] 20,692	6,428	130,379

[1] Includes Delaware, New York, Virginia, and West Virginia.
[2] Includes Minnesota, Missouri, Nebraska, North Dakota, Tennessee, and Wisconsin.
[3] Includes 2,079,000 barrels of isobutane used for petrochemical feedstock.

Table 13.—Refinery input stocks of natural gas plant products

(Thousand

	PAD district I			PAD district II				
	East Coast	Appalachian #1	Total	Appalachian #2	Ind., Ill., Ky.	Minn., Wisc., N.D., S.D.	Okla., Kans., Mo.	Total
Natural gas plant products:								
Refinery inputs:								
Propane	--	--	--	--	5	--	--	5
Isobutane	36	37	73	--	3,383	1,287	5,457	10,127
Normal butane	215	--	215	--	3,846	1,435	4,006	9,287
Other butane	--	53	53	--	4,211	693	1,609	6,513
Butane-propane mix	--	--	--	--	305	--	35	340
Natural gasoline	889	9	898	--	7,162	1,603	11,417	20,182
Plant condensate	487	960	1,447	475	13,497	6,618	--	20,590
Total	1,627	1,059	2,686	475	32,409	11,636	22,524	67,044
Stocks at refineries:[1]								
Propane	--	--	--	--	--	--	--	--
Isobutane	--	--	--	--	40	15	179	234
Normal butane	4	--	4	--	14	8	235	257
Other butane	--	--	--	--	--	22	22	44
Butane-propane mix	--	--	--	--	2	--	3	5
Natural gasoline	--	--	--	--	40	44	117	201
Plant condensate	--	--	--	--	142	42	--	184
Total	4	--	4	--	238	131	556	925
Liquefied refinery gases:								
Refinery outputs:								
Propane and/or propylene	14,934	1,396	16,330	324	16,322	1,235	7,693	25,574
Butane and/or butylene	1,448	30	1,478	--	707	49	372	1,128
Butane-propane mix	106	6	112	--	5	222	163	390
Isobutane	--	--	--	--	--	--	51	51
Total	16,488	1,432	17,920	324	17,034	1,506	8,279	27,143
Stocks at refineries:[1]								
Propane and/or propylene	820	20	840	2	1,038	20	137	1,197
Butane and/or butylene	9	--	9	--	191	2	30	223
Butane-propane mix	--	--	--	--	--	2	39	41
Isobutane	--	--	--	--	--	--	39	39
Total	829	20	849	2	1,229	24	245	1,500

[1] Stocks as of Dec. 31, 1972.

and refinery output and stocks of liquefied refinery gases, by product
barrels)

PAD district III						PAD dist. IV	PAD dist. V	
Texas Inland	Texas Gulf	La. Gulf	North La., Ark.	N. Mex.	Total	Other Rocky Mt.	West Coast	United States
710	254	2,887	--	--	3,851	--	78	3,934
6,437	7,479	6,767	912	222	21,817	878	1,734	34,629
1,140	8,240	8,103	246	442	18,171	782	3,345	31,800
477	1,333	516	6	8	2,340	1,238	1,220	11,364
--	1,112	764	4	--	1,880	374	872	3,466
16,396	89,005	24,203	1,034	555	131,193	1,603	10,186	164,062
24	12,121	2,026	2,076	--	16,247	11,376	3,530	53,190
25,184	119,544	45,266	4,278	1,227	195,499	16,251	20,965	302,445
--	--	149	--	--	149	41	--	190
39	409	698	9	2	1,157	16	24	1,431
40	614	341	3	5	1,003	7	11	1,282
6	7	68	--	--	81	9	9	143
--	--	15	--	--	15	11	--	31
373	620	90	62	11	1,156	9	52	1,418
--	199	--	65	--	264	62	--	510
458	1,849	1,361	139	18	3,825	155	96	5,005
2,615	20,945	16,358	576	216	40,710	1,511	9,937	94,062
893	8,500	2,265	157	243	12,058	550	3,399	18,613
7	616	2,788	215	--	3,626	181	2,119	6,428
63	884	--	--	--	947	6	1,075	2,079
3,578	30,945	21,411	948	459	57,341	2,248	16,530	121,182
70	753	2,085	6	4	2,918	19	178	5,152
131	46	1,504	5	--	1,686	10	248	2,176
--	12	--	4	--	16	5	307	369
--	4	--	--	--	4	3	38	84
201	815	3,589	15	4	4,624	37	771	7,781

Table 14.—Refinery input of LPG by product and PAD district

(Thousand barrels)

Item	PAD district I	II	III	IV	V	United States
1970						
Propane	--	50	580	9	867	1,506
Normal butane	690	8,668	16,479	1,023	437	27,297
Other butanes	1,200	6,234	2,895	1,230	3,138	14,697
Isobutane	277	9,244	20,686	911	1,181	32,299
Butane-propane mix	--	1,548	2,296	389	275	4,508
Total LPG	2,167	25,744	42,936	3,562	5,898	80,307
1971						
Propane	257	59	2,506	--	451	3,273
Normal butane	686	8,402	15,759	847	3,669	29,363
Other butanes	11	6,105	2,651	1,163	1,191	11,121
Isobutane	24	9,648	19,547	925	2,207	32,351
Butane-propane mix	--	417	2,065	371	734	3,587
Total LPG	978	24,631	42,528	3,306	8,252	79,695
1972						
Propane	--	5	3,851	--	78	3,934
Normal butane	215	9,287	18,171	782	3,345	31,800
Other butanes	53	6,513	2,340	1,238	1,220	11,364
Isobutane	73	10,127	21,817	878	1,734	34,629
Butane-propane mix	--	340	1,880	374	872	3,466
Total LPG	341	26,272	48,059	3,272	7,249	85,193

Table 15.—Stocks of natural gas liquids and ethane in the United States

(Thousand barrels)

Date	LPG and ethane: At plants and terminals	LPG and ethane: At refineries	Natural gasoline and isopentane: At plants and terminals	Natural gasoline and isopentane: At refineries	Other finished products and plant condensate: At plants and terminals	Other finished products and plant condensate: At refineries	Total at plants and terminals	Total at refineries	Grand total
Dec. 31:									
1968	71,140	647	2,628	1,860	1,528	137	75,296	2,644	77,940
1969	53,981	571	3,368	1,557	1,203	232	58,552	2,360	60,912
1970	60,595	794	4,323	1,765	1,074	451	65,992	3,010	69,002
1971	83,659	3,693	3,678	1,485	1,084	419	88,421	5,597	94,018
1972:									
Jan. 31	71,816	4,048	3,636	1,672	1,252	381	76,704	6,101	82,805
Feb. 29	63,253	2,898	3,777	1,594	1,202	446	68,232	4,938	73,170
Mar. 31	63,741	2,578	3,858	1,622	1,178	461	68,777	4,661	73,438
Apr. 30	69,803	2,661	3,940	1,554	1,358	438	75,101	4,653	79,754
May 31	79,736	4,503	3,965	1,420	1,283	605	84,984	6,528	91,512
June 30	88,013	4,782	3,711	1,439	1,107	504	92,831	6,725	99,556
July 31	95,378	5,118	3,825	1,464	1,160	385	100,363	6,967	107,330
Aug. 31	99,342	5,503	3,836	1,745	1,219	601	104,397	7,849	112,246
Sept. 30	103,723	5,078	3,942	1,521	1,188	732	108,853	7,331	116,184
Oct. 31	100,368	4,608	3,629	1,591	1,101	686	105,098	6,885	111,983
Nov. 30	90,192	3,449	3,487	1,399	994	609	94,673	5,457	100,130
Dec. 31	74,859	3,077	3,384	1,418	995	510	79,238	5,005	[1] 84,243

[1] Includes 61,131,000 barrels in underground storage.

Table 16.—Average monthly prices, liquefied petroleum gas (propane) in the United States

(Cents per gallon)

	Jan.	Feb.	Mar.	Apr.	May	June	July
New York harbor and Philadelphia:[1]							
1971	9.00	9.00	9.00	8.58	8.50	8.50	8.50
1972	8.50	8.50	8.50	8.50	8.50	8.50	8.50
Oklahoma:[1]							
1971	6.25	6.25	6.13	5.75	5.75	5.75	5.75
1972	5.25	5.25	5.25	5.25	5.25	5.25	5.25
Baton Rouge, La.:[1]							
1971	6.73	6.73	6.23	5.73	5.73	5.73	5.73
1972	5.73	5.73	5.73	5.73	5.73	5.73	5.73
Mt. Belvieu, Tex.:[2]							
1971	6.73	6.73	6.18	5.58	5.58	5.58	5.58
1972	5.58	5.58	5.58	5.58	5.58	5.58	5.58

	Aug.	Sept.	Oct.	Nov.	Dec.	Average for year
New York harbor and Philadelphia:[1]						
1971	8.50	8.50	8.50	8.50	8.50	8.63
1972	8.50	8.95	9.18	9.18	9.18	8.71
Oklahoma:[1]						
1971	5.75	5.75	5.67	5.25	5.25	5.78
1972	5.25	5.60	5.67	5.67	5.67	5.38
Baton Rouge, La.:[1]						
1971	5.73	5.73	6.14	5.73	5.73	5.97
1972	5.73	6.12	6.21	6.21	6.21	5.88
Mt. Belvieu, Tex.:[2]						
1971	5.58	5.58	5.99	5.58	5.58	5.86
1972	5.58	5.93	6.02	6.02	6.02	5.71

[1] Producer's net contract prices (after some discounts and summer-fill allowances) for propane, tank cars and/or transport trucks.

[2] For pipeline input, minimum 10,000 barrels.

Source: Platt's Oil Price Handbook and Oilmanac.

Table 17.—LPG [1] exported from the United States, by country

(Thousand barrels and thousand dollars)

Country	1971				1972			
	Butane	Propane	Butane-propane mixtures	Total	Butane	Propane	Butane-propane mixtures	Total
Bahamas	(2)	67	(2)	67	(2)	26	(2)	26
Brazil	56	--	1	57	47	--	--	47
Canada	12	9	76	97	10	11	97	118
France	--	--	--	--	--	28	(2)	28
Guatemala	--	--	19	19	--	--	5	5
Japan	10	3	1	14	(2)	888	(2)	888
Mexico	831	2,008	6,236	9,075	759	2,773	6,798	10,330
Netherlands	(2)	--	(2)	(2)	12	--	(2)	12
United Kingdom	(2)	29	1	30	(2)	1	1	2
Other	7	8	5	20	3	9	7	19
Total	916	2,124	6,339	9,379	831	3,736	6,908	11,475
Total value	$2,984	$6,834	$19,417	$29,235	$2,672	$23,192	$20,717	$46,581

[1] Data include LRG.
[2] Less than ½ unit.

Source: Bureau of the Census.

Nickel

By Horace T. Reno [1]

Nickel supply came into closer balance with demand in 1972 because some of the lower grade, high-cost mines were shut down and nickel consumption in the United States, Western European countries, and Japan increased rapidly. Nevertheless, a large surplus nickel supply remained in the producers' inventory that built up in 1970 and 1971.

Canadian nickel producers raised the quoted base price for pure nickel by approximately 15% the first of September. Producers in other countries except the United States followed the Canadian lead.

The U.S. nickel industry was little affected by the worldwide imbalance between supply and demand. The domestic price was not changed until late in the year when the price of domestically produced ferronickel was raised approximately 7%. Domestic consumers used 25% more nickel in 1972 than in 1971 and more than doubled their use of ferronickel.

The President approved legislation on July 26, 1972, that authorized disposal of all nickel held in the national stockpile. Stockpile nickel did not reach the open market during the year.

Table 1.—Salient nickel statistics

(Short tons)

	1968	1969	1970	1971	1972
United States:					
Mine production	17,294	17,056	15,933	17,036	16,864
Plant production:					
Primary	15,241	15,810	15,558	15,654	15,731
Secondary	14,061	18,775	23,159	29,657	35,926
Exports	33,681	34,758	31,456	26,143	21,671
Imports for consumption	147,950	129,332	156,252	142,183	173,870
Consumption	159,306	141,737	155,719	128,802	159,286
Stocks Dec. 31: Consumer	27,466	16,574	24,708	16,005	26,205
Price ... cents per pound	94–103	103–128	128–133	133	133–153
World: Mine production	547,960	536,608	692,710	699,906	698,007

DOMESTIC PRODUCTION

The Hanna Mining Co. at Riddle, Oreg., was the sole producer of primary nickel in the United States. Byproduct nickel salts were produced at copper and other metal refineries. Part of the byproduct nickel originated from scrap.

[1] Physical scientist, Division of Ferrous Metals.

Table 2.—Primary nickel produced in the United States

(Short tons, nickel content)

	1968	1969	1970	1971	1972
Byproduct of metal refining	2,117	2,714	2,909	2,581	2,505
Domestic ore	13,124	13,096	12,649	13,073	13,226

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	1971	1972	Form of recovery	1971	1972
New scrap:			As metal	854	1,166
Nickel-base	r 1,247	3,038	In nickel-base alloys	r 2,093	2,694
Copper-base	r 3,357	1,948	In copper-base alloys	r 5,332	6,738
Aluminum-base	465	500	In aluminum-base alloys	774	1,056
Total	r 5,069	5,486	In ferrous and high-temperature alloys [1]	17,586	24,003
Old scrap:			In chemical compounds	197	269
Nickel-base	20,832	29,440	Total	r 26,836	35,926
Copper-base	577	600			
Aluminum-base	358	400			
Total	21,767	30,440			
Grand total	r 26,836	35,926			

r Revised.
[1] Includes only nonferrous nickel scrap added to ferrous and high-temperature alloys.

CONSUMPTION AND USES

The domestic nickel industry used more than twice as much nickel in the form of ferronickel in 1972 than it used in 1971. Essentially all of it was used in stainless and alloy steels. The pattern of nickel consumption in 1972 was changed little from that of 1971; 28% of the total consumed was used to make stainless steels, 12% was used in alloy steels, 18% was used in nickel plating, 26% was used to make high-nickel alloys and superalloys, and 3% was used in iron castings. International Nickel Co. of Canada, Ltd. (INCO), which in the past has reported statistics on the end-use consumption pattern, did not do so for 1972 because of the growing markets in Eastern Europe, the U.S.S.R., and Asia, areas for which accurate statistics are unavailable. Nevertheless, INCO reported little alteration in consumption either as to end use or geographical area. End-use market information available to the Bureau of Mines did not indicate any substantial change in the worldwide pattern of nickel usage.

Table 4.—Stocks and consumption of new and old nickel scrap in the United States in 1972

(Gross weight, short tons)

Class of consumer and type of scrap	Stocks, beginning of year	Receipts	Consumption: New	Consumption: Old	Consumption: Total	Stocks, end of year
Smelters and refiners:						
Nickel and nickel alloys	502	9,632	729	6,543	7,272	2,862
Monel metal	998	4,938	611	2,308	2,919	3,017
Nickel silver [1]	441	2,897	815	2,067	2,882	456
Cupronickel [1]	78	587	--	525	525	140
Nickel residues	5,816	1,621	5,501	--	5,501	1,936
Total	7,316	16,191	6,841	8,851	15,692	7,815
Foundries and plants of other manufacturers:						
Nickel and nickel alloys	14,672	17,023	1	27,934	27,935	3,760
Monel metal	19	136	10	136	146	9
Nickel silver [1]	2,397	12,112	11,990	--	11,990	2,519
Cupronickel [1]	1,253	16,589	16,120	100	16,220	1,622
Nickel residues	184	80	--	155	155	109
Total	14,875	17,239	11	28,225	28,236	3,878
Grand total:						
Nickel and nickel alloys	15,174	26,655	730	34,477	35,207	6,622
Monel metal	1,017	5,074	621	2,444	3,065	3,026
Nickel silver [1]	2,838	15,009	12,805	2,067	14,872	2,975
Cupronickel [1]	1,331	17,176	16,120	625	16,745	1,762
Nickel residues	6,000	1,701	5,501	155	5,656	2,045
Total	22,191	33,430	6,852	37,076	43,928	11,693

[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	1968 [1]	1969 [1]	1970 [1]	1971 [1]	1972 [1]
Metal	115,839	99,096	112,825	95,639	110,422
Ferronickel	15,170	17,804	15,230	r 11,515	22,806
Oxide powder and oxide sinter	24,362	19,133	21,369	r 16,554	19,315
Salts	3,935	2,647	3,792	2,376	3,939
Other	--	3,057	2,503	2,718	2,804
Total	159,306	141,737	155,719	r 128,802	159,286

r Revised.
[1] Metallic nickel salts consumed by plating industry are estimated.

Table 6.—U.S. consumption of nickel (exclusive of scrap), by use and form, 1972

(Short tons)

Use	Commercially pure unwrought nickel	Ferro-nickel	Nickel oxide	Nickel sulfate and other nickel salts	Other forms	Total of figures shown
Steel:						
Stainless and heat-resisting	17,155	16,788	11,196	--	227	45,366
Alloys (excludes stainless)	7,930	5,004	6,408	--	213	19,555
Superalloys	11,536	251	49	--	436	12,272
Nickel-copper and copper-nickel alloys	8,307	--	36	--	199	8,542
Permanent magnet alloys	3,925	221	54	--	--	4,200
Other nickel and nickel alloys	27,873	269	698	5	49	28,894
Cast irons	2,825	272	401	--	938	4,436
Electroplating [1]	25,351	--	31	3,547	107	29,036
Chemicals and chemical uses	906	--	71	204	--	1,181
Other uses [2]	4,614	1	371	183	635	5,804
Total reported by companies canvassed and estimated	110,422	22,806	19,315	3,939	2,804	159,286

[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	1970	1971 r	1972
Metal	17,944	11,499	18,174
Ferronickel	2,249	2,539	3,990
Oxide powder and oxide sinter	3,304	970	2,794
Salts	498	381	446
Other	713	616	801
Total	24,708	16,005	26,205

r Revised.

PRICES

The producers' price for electrolytic nickel was increased from $1.33 to $1.53 per pound the first of September. Prices were unchanged for domestically produced nickel in ferronickel until December 14 when the quoted price was raised from $1.28 to $1.38 per pound. The price changes for nickel produced in foreign countries widened the differential between prices quoted for pure nickel and that quoted for nickel in ferronickel and in other forms of nickel especially suited for steelmaking. The top grade of ferronickel produced in New Caledonia was quoted at $1.42 per pound of contained nickel, an increase of 12 cents per pound effective September 25.

FOREIGN TRADE

The gross weight of U.S. exports of nickel, nickel alloys, and nickel catalysts was 34% less in 1972 than that in 1971. Export of nickel scrap increased 14% over that of 1971.

U.S. foreign trade in nickel in 1972 was marked by greatly increased imports of nickel in ferronickel, 76% more than was imported in 1971. Most of the ferronickel imported originated in New Caledonia. Nickel-bearing ore was imported from Colombia, the Philippines, and Canada for use in pilot plant research operations. The total of nickel in all forms imported for consumption in 1972 was 21% more than was imported in 1971. Canada continued as the principal supplier but with 8 percentage points less of the total than in 1971. Imports of nickel from the U.S.S.R. increased more than fourfold compared with that imported in 1971.

Table 8.—U.S. exports of nickel and nickel alloy products, by class

Class	1970 Short tons	1970 Value (thousands)	1971 Short tons	1971 Value (thousands)	1972 Short tons	1972 Value (thousands)
Unwrought	6,103	$13,450	4,287	$8,614	2,178	$6,469
Bars, rods, angles, shapes, sections	5,311	16,047	4,904	16,828	2,140	9,038
Plates, sheets, strip	4,653	21,893	3,351	14,675	3,455	16,625
Anodes	160	600	334	1,147	481	1,490
Wire	870	5,642	643	3,269	553	2,638
Powder and flakes	281	2,405	696	2,754	341	2,800
Foil	18	76	7	41	11	28
Catalysts	2,524	6,451	3,740	10,018	2,573	6,794
Tubes, pipes, blanks, fittings therefore, hollow bars	1,756	6,520	2,134	9,985	1,499	8,831
Waste and scrap	9,780	12,840	6,047	7,239	8,440	9,055
Total	31,456	85,924	26,143	74,570	21,671	63,768

Table 9.—U.S. imports for consumption of nickel products, by class

Class	1970 Short tons	1970 Value (thousands)	1971 Short tons	1971 Value (thousands)	1972 Short tons	1972 Value (thousands)
Ore	21	$251	13,173	$297	258	$6
Unwrought	117,334	302,578	r 100,531	259,931	125,364	330,825
Oxide and oxide sinter	6,423	12,611	5,769	11,604	5,988	12,038
Slurry [1]	35,114	82,643	32,944	73,656	28,222	57,085
Bars, plates, sheets, anodes	177	773	79	302	198	683
Rods and wire	544	2,630	768	3,642	694	2,964
Shapes, sections, angles	2	12	(2)	1	1	7
Pipes, tubes, fittings	22	97	10	47	63	314
Powder	3,050	10,416	1	3	4,499	14,109
Flakes	76	207	2,708	8,234	331	909
Waste and scrap	2,149	4,485	1,336	1,896	2,306	3,517
Ferronickel	14,251	9,834	26,233	16,986	51,741	35,857
Total (gross weight)	179,163	426,537	183,552	376,599	219,665	458,314
Nickel content (estimated)	156,252	XX	142,183	XX	173,870	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] Less than ½ unit.

Table 10.—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]			
	1971	1972	1971	1972	1971	1972	1971		1972	
	(Gross weight)		(Gross weight)		(Gross weight)		Gross weight	Nickel content	Gross weight	Nickel content
Australia	457	487	297	195	--	--	r 145	r 39	--	--
Canada	87,040	97,250	694	1,487	5,728	5,967	r 29,752	r 24,428	28,188	22,792
Finland	21	55	--	2	--	--	--	--	--	--
France	181	558	45	249	28	15	--	--	(3)	(3)
Germany, West	50	561	8	11	--	--	r 44	r 10	--	--
Mozambique	--	67	--	--	--	--	--	--	--	--
Netherlands	408	166	--	--	--	--	--	--	11	3
Norway	11,067	17,295	43	--	--	--	--	--	--	--
Rhodesia, Southern	--	1,801	--	--	--	--	--	--	--	--
South Africa, Republic of	929	2,791	122	215	13	--	r 2,977	r 1,349	--	--
Sweden	25	(3)	--	--	--	--	--	--	--	--
U.S.S.R	22	94	--	6	--	--	--	--	--	--
United Kingdom	329	4,135	1,499	2,645	(3)	--	r 26	r 3	23	21
Uruguay	--	70	--	--	--	--	--	--	--	--
Other	2	34	1	20	--	6	--	--	--	--
Total	100,531	125,364	2,709	4,830	5,769	5,988	r 32,944	r 25,829	28,222	22,816

r Revised.

[1] Ore: 1971, 13,173 short tons: Australia 2,196, French Pacific Islands 5,566, Colombia 4,314, Philippines 1,097, Canada less than 1 short ton; 1972, 258 short tons: Canada 52, Colombia 70, Philippines 136.

[2] 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.

[3] Less than ½ unit.

WORLD REVIEW

Australia.—Western Australia's nickel boom of the last 4 years was moderated somewhat by the oversupply of nickel around the world; however, nickel production increased 10% compared with that of 1971. Western Mining Corp., Ltd., again increased its reserves, and by the end of the year, the corporation had essentially completed a new flash smelter at Kalgoorlie. The Kalgoorlie smelter has a designed capacity of 25 tons of nickel concentrate per hour. It utilizes the Outokumpu Oy smelting process. Western Mining Corp.'s progress is a good measure of the rapidity with which the nickel industry of Western Australia has developed into a significant worldwide supplier. Just 5 years after first nickel production, Western Mining was the world's fourth largest producer of nickel and opened a sales office in the United States at Pittsburgh, Pa., to market nickel to North American consumers.

Construction of the mining plant and infrastructure for the Greenvale nickeliferous laterite deposits in Queensland was started, and the work proceeded as scheduled.

Poseidon Ltd.'s joint venture with Homestake Mining Co. and Hanna Mining Co. to exploit the Windarra deposit in Western Australia was disbanded, and Poseidon entered an agreement with Western Mining Corp. and Sherritt Gordon Mines Ltd. of Canada for sale of concentrates produced from the Windarra deposit. Reportedly, the Poseidon company will have some support on the project from the Australian Government.

The Agnew nickel prospect, 200 miles northwest of Kalgoorlie, discovered in 1971 by Selcast Exploration Ltd., a subsidiary of Selection Trust Ltd. of London, was proved a significant find. By yearend it was reported that the Agnew deposit contained 33 million tons of ore averaging 2.2% nickel at a cutoff grade of 1%.[2]

The Western Australian Government considered providing support in building infrastructure that serves the developing nickel and other mineral industries of the state. Reportedly, the most likely aid would be help in building a railway to Kalgoorlie continuing west to the Port of Geralton.

[2] Northern Miner. Major Nickel Orebody Shaping From Agnew Find in Australia. V. 58, No. 41, Dec. 28, 1972, p. 14.

Botswana.—The way was cleared for development of the Pikwe-Selebi copper-nickel deposits when agreements for financing the project were signed at Gaborone in March.

Canada.—Canadian nickel production in 1972 was 13% less than in 1971 because INCO cut back its mining operations 10% early in the year to adjust output to market conditions. At yearend INCO had 14 mines operating, 11 in Ontario and 3 in Manitoba. INCO's Maclennan mine in the Sudbury district was depleted, and its Shebandoan mining and milling complex in Northern Ontario was brought into production as planned.

Prospecting and exploration of nickel and copper-nickel properties continued at a high level of activity, little influenced by the worldwide imbalance between supply and demand. INCO and Falconbridge Nickel Mines Ltd. were active in exploration in Quebec, Ontario, and Manitoba. INCO did not report developments at specific properties in its annual report for the year. Falconbridge reported that underground drilling at its Onaping mine indicated a new significant sulfide zone and that diamond drilling from a drift on the 1,000-foot level at the Bucko Lake property of Bowden Lake Nickel Mines Ltd. was in nickel mineralization. Falconbridge had a 60% interest in the property.

Great Lakes Nickel Ltd. of Toronto, Ontario, and Boliden AB of Stockholm, Sweden, announced an agreement under which the Swedish company will study the feasibility of producing copper and nickel concentrates from the large low-grade copper-nickel property on which Great Lakes Nickel has indicated 106 million tons of 0.4% copper, 0.2% nickel ore. A feasibility study made for the Ontario Government indicated that a copper smelter-refinery in northern Ontario would not be economically viable unless large copper ore bodies are discovered. The study cited the Great Lakes Nickel Ltd. project as a possibility.

The principal Canadian nickel producers and their 1972 production, sales, or deliveries to customers as given in their annual report to stockholders were as follows:

Company	Type of operation	Thousand pounds
The International Nickel Co. of Canada, Ltd	Delivery	425,080
Falconbridge Nickel Mines Ltd	Delivery	89,665
Sherritt Gordon Mines Ltd	Sales	20,414

Environmental improvement in the Sudbury district was a major element in the operations of both INCO and Falconbridge. INCO commissioned a 1,250-foot chimney and a gas cleaning system and capped the three chimneys that it replaced. Falconbridge shut down its pyrrhotite processing plant until a process is developed to eliminate sulfur dioxide (SO_2) emissions. Both companies recycled processing waters and seeded barren land in the vicinity of their plants.

Falconbridge closed its nickel-iron refinery after 2 years of operation failed to achieve continuous production of specification products. Reports to the Bureau of Mines from U.S. consumers of the Falconbridge nickel-iron indicated that the material that reached the market was a satisfactory source of nickel for use in steelmaking.

Colombia.—Colombian Nickel Co. (CONICOL) and the Industrial Development Institute of Colombia (IFI) were renegotiating portions of their concession agreement to exploit nickel deposits at Cerro Matoso in the Department of Córdoba.

Cuba.—The Government of the Republic of Cuba announced that it had reached agreement with the Government of the U.S.S.R. for credits to finance general repair and reconstruction of the existing nickel plants at Moa Bay and Nicaro and to expand the mining base at both plants. Moreover, it announced that Cuban and Soviet organizations will collaborate on construction of the first phase of a mining-metallurgical complex with an annual output capacity of 30,000 tons of nickel and cobalt at Punta Gorda. The approximate distribution of credits for the projects was 52 million rubles (US$63.18 million) for rehabilitation of Nicaro and Moa Bay and 15 million rubles (US$18.225 million) for the Punta Gorda complex. The ultimate investment needed to raise Cuban production to 90,000 tons of nickel annually was estimated at $600 million, not including the funds required for the infrastructure, housing, and energy.

Dominican Republic.—The ferronickel plant of Falconbridge Dominicana C. por A. was officially inaugurated by His Excellency Dr. Waukeen Balenguer, President of the Republic. The plant produced about 46,000 tons of ferronickel during the year, approximately 70% of its rated annual capacity.

Greece.—Société Minière et Métallurgique de Larymna S.A. (LARCO), the only active nickel producer in Greece, engaged in an expansion program designed to increase its nickel productive capacity from 1,100 to 1,750 tons per month.

Indonesia.—Indonesian production of nickel in 1972 was stimulated by a pricing dispute between Japanese consumers and the nickel producers in other areas of the Pacific. With Japanese help, PN Aneka Tambang (Aneka), the state mining corporation, was building a smelter at Pomalaa to process low-grade (1.8% nickel) laterite to 22% ferronickel. P.T. International Nickel Indonesia, a wholly owned subsidiary of INCO, announced agreement with six Japanese companies for equity participation in its planned nickeliferous laterite mining and processing facilities on the island of Sulawesi. The Japanese companies are to provide sales of the ferrous laterite mining and processing facilities project output over a 15-year period. It is expected that INCO's equity in the project will be 60% and that of the Japanese participants 20%; the remainder will be held by Indonesians.

New Caledonia.—Nickel ore production in New Caledonia in 1972 was 2% less than that produced in 1971 because a disagreement on prices with Japanese consumers shut down a large segment of the independent nickel mining industry. However, ore mining by that segment of the industry producing for processing in New Caledonia increased. Overall nickel production was down 4% compared with that in 1971, but ferronickel and matte production increased 28% and 25% respectively. Nickel ore exports to Japan were 42% less than exports in 1971.

The high level of production of nickel products in New Caledonia was maintained with the help of a group of consumers in France that, under French Government guidance, established a nickel stockpile of 38 million pounds.

The worldwide imbalance between nickel supply and demand delayed some planned nickel projects in New Caledonia and caused revision of others. The agreement

Table 11.—Nickel: World production [1] by country

(Short tons)

Country [2]	1970	1971	1972 [p]
Australia (content of concentrate)	[r] 32,810	35,866	39,442
Brazil (content of ore) [e]	3,200	3,500	3,500
Burma (content of speiss)	23	26	29
Canada [3]	305,881	294,342	256,467
Cuba:			
Content of oxide [e]	20,400		
Content of sulfide [e]	18,400	[r] 39,000	40,000
Dominican Republic	--	220	19,800
Finland:			
Content of concentrates	5,634	3,867	5,700
Content of nickel sulfate	165	136	[e] 165
Greece (recoverable content of ore)	9,526	[p] 11,800	[e] 12,100
Indonesia (content of ore) [4]	[r] 17,200	21,800	24,738
Mexico (content of ore)	49	[e] 55	[e] 55
Morocco (content of nickel ore and cobalt ore)	152	[e] 220	254
New Caledonia (recoverable) [5]	116,164	112,751	110,424
Norway (content of concentrate)	234	[e] 220	[e] 220
Poland (content of ore) [e]	2,200	[r] 2,200	2,200
Rhodesia, Southern (content of concentrate) [e]	12,000	[r] 12,800	13,200
South Africa, Republic of [6]	12,739	14,067	12,849
U.S.S.R. (content of ore) [e]	120,000	130,000	140,000
United States	15,933	17,036	16,864
Total	[r] 692,710	699,906	698,007

[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 are used in lieu of actual reported mine output as a measure of mine output. The following table gives metallurgical plant output, including data for countries that mine no nickel, but that process imported ores, concentrates, and/or other crude materials.

[2] In addition to the countries listed, Albania and East Germany also produce nickel from mines, but available information is inadequate to make reliable estimates of output levels.

[3] Refined nickel and nickel content of oxides and salts produced, plus recoverable nickel in matte and concentrates exported.

[4] Includes a small amount of cobalt not recovered separately.

[5] Nickel-cobalt content of metallurgical plant products, plus recoverable nickel-cobalt in exported ores.

[6] Reported erroneously as refined metal in previous editions.

Table 12.—Nickel: World smelter production[1] by country

(Short tons)

Country[2]	1970	1971	1972 p
Australia	1,100	15,400	17,600
Brazil[3]	2,900	2,900	3,100
Canada[3]	208,700	182,500	145,200
Cuba e[3]	40,000	35,000	37,000
Czechoslovakia e	900	900	900
Dominican Republic[4]	--	374	19,800
Finland	4,419	4,288	[3] 6,100
France	11,360	9,486	[3] 14,440
Germany, West	622	220	220
Greece	9,526	p 11,800	e 12,100
Japan[5]	99,100	112,400	119,000
New Caledonia[6]	48,304	50,728	65,384
Norway	42,415	46,058	47,739
Poland e	2,200	2,200	2,200
Rhodesia, Southern e[3]	5,500	7,700	8,800
South Africa, Republic of[3]	9,900	9,900	9,700
United Kingdom	40,500	42,700	[3] 35,200
U.S.S.R. e	120,000	130,000	140,000
United States:[7]			
Byproduct of metal refining	2,909	2,581	2,505
Recovery from domestic ore	12,649	13,073	13,226
Total	663,004	680,208	700,214

e Estimate. p Preliminary.

1 Refined nickel plus nickel content of ferronickel produced from concentrates unless otherwise specified.

2 In addition to the countries listed, East Germany and North Korea are 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.

4 Nickel-cobalt content of ferronickel only (no refined nickel is produced).

5 Includes electrolytic nickel as follows 1970—14,763; 1971—17,077; 1972—18,189; the difference between these figures and the listed total is the nickel content of ferronickel, nickel oxide and nickel fonte.

6 Nickel content of ferronickel and matte.

7 Electrolytic nickel only.

between Société Le Nickel, S.A. and Patiño Mining Corp. to build a powerplant, erect a town, develop a harbor and port, and build a smelter in Poum on the northern tip of the island was allowed to lapse. However, Patiño entered an agreement to continue the project with Pechiney Ugine Kuhlmann (PUK) of France and the Gränges Co. of Sweden. The three concerns formed Société Metallurgique de Nickel Patiño Pechiney Gränges (SOMMONI), a new company that will manage the work. The Patiño subsidiary Compagnie Française d'Entreprises Minères, Métallurgiques et d'Investessiments (COFREMMI) was to own 42% of SOMMONI: PUK, 38%; and Gränges, 20%.

The French Government negotiated with three other concerns for mining lateritic nickel ores of New Caledonia: (1) International Nickel Co. of Canada, Ltd., which was attempting to organize a project for the production of 45 million pounds of nickel and 3 million pounds of cobalt annually, (2) Penamax, formed by American Metal Climax, Inc., and (3) Société Nationale des Pétroles d'Aquitaine of France and Freeport Minerals Corp. of the United States. At yearend none of the three potential projects were approved.

Philippines.—Marinduque Mining and Industrial Corp. (MMIC) announced that it was selling $3 million worth of its stock to raise the money needed to complete its equity share of the capital required to construct a laterite mining plant on the Surigao mineral reservation. Apparently the project was still viable despite numerous delays and the dampening effect of the world imbalance between supply and demand.

Atlas Consolidated Mining and Development Corp. began testing a 1,000-ton, bulk sample of Palawan ore preliminary to exercising its right of first refusal to exploit the properties. Reportedly, Soriano and Co. has proved reserves of 284 million tons containing 1.29 to 1.42% nickel at Palawan. Japanese companies negotiated for 1,000 tons of nickel concentrate per year from the Palawan deposits.

TECHNOLOGY

The pattern of nickel research and development in 1972 was little changed from that of the last 2 years. Scientists at Bureau of Mines laboratories researched methods of recovering nickel and copper from the Duluth gabbro of Minnesota. One element of the overall investigation was a study looking to pressure leaching of nickel-bearing gabbro in situ. The plan was to fracture the gabbro with nuclear explosives.

In the oxide ore phase of the Bureau's extractive research program, metallurgists studied segregation and chloridization processes. They reported a simple, low-cost roasting modification for improving nickel and cobalt extraction from relatively refractory, low-grade, weathered serpentine. The process was described in a Bureau of Mines Technical Progress Report.[3]

Apparently the pattern of research in the U.S.S.R. has followed that of the free world. It was reported that nickel production had been increased 37% in the 5-year plan period between 1966 and 1970. The increase was due to introduction of new technology, automation, mechanization, improvements in processes, and modernization of mining and metallurgical equipment. Oxygen-enriched airblast into a shaft smelting furnace, autoclave leaching to increase production of nickel hydroxide, and replacement of multiple hearth roasters by closed-system fluo-solids furnaces were among the technical improvements.[4]

The Division of Mineralogy of the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO) began a comprehensive investigation on the nature of deposition and mode of origin of the nickel sulfide ores of Australia. The program was designed to develop a genetic model that is consistent and adequately understood. The initial work was an interpretive study of nickel-iron sulfide ore in the Lunnon shoot at Kambalda, Western Australia.[5] A magmatic model for the formation of the shoot was developed as a result of study of one intersection of the ore body. The data suggested that at temperatures above 1,140° C, the ore and its host ultramafic rock consisted of a crystal mush containing olivine and chromite crystals, sulfide droplets, and silicate magma.

CSIRO researchers also began collecting representative samples of nickeliferous oxide ores from various Australian deposits to determine their response to known hydrometallurgical procedures.[6]

Mining engineers of INCO, reported on more than 10 years of progress in raise boring at the Sudbury district nickel mines.[7] Improved safety in ground control, lower resistance to air flow, and reduced cost were cited as the advantages in raise boring.

The Republic Steel Corp. of Cleveland, Ohio, reported a new hydrometallurgical process for recovering nickel.[8] Metallurgists of the company worked with the Colorado School of Mines Research Institute on a feasibility study and pilot plant operation to test a number of lateritic ores. They reported that using hydrometallurgical techniques at elevated temperatures with additives of sulfur, oxygen, and metallic iron, the new process achieved 92% nickel recovery.

Informal reports from industrial research laboratories indicated a high level of activity in the search for new nickel applications, but as in 1971, the intensified research was not reflected in the published literature. Armco Steel Corp. described a new 5% nickel alloy to compete with ferritic and austentic nickel stainless steel.[9] The 5% nickel steel was said to increase the versatility of the nickel steels in handling and storage of liquified gases with special emphasis on liquid natural gas (LNG). Most LNG facilities have been built of alloy steels containing 9% nickel.

[3] Brooks, P. T., and G. M. Potter. Improving Nickel Extraction from Oxide Nickel Ores. BuMines TPR 57, September 1972, 4 pp.

[4] Murashov, V. D. Improvements in Nickel Technology. Intermet Bull., v. 1, No. 4, April 1972, p. 41.

[5] Ewers, W. E., and D. R. Hudson. An Interpretive Study of a Nickel-Iron Sulfide Ore Intersection, Lunnon Shoot, Kambalda, Western Australia. Econ. Geol., v. 67, No. 8, December 1972, pp. 1075–1092.

[6] CSIRO Minerals Research Laboratories Annual Report, 1971–72, p. 20.

[7] Parris, T. D., and W. J. Taylor. Raise Boring at the International Nickel Company of Canada, Limited, Ontario Division. Can. Min. and Met. Bull., v. 65, No. 723, July 1972, pp. 25–30.

[8] Canadian Mining and Metallurgical Bulletin. Hydrometallurgical Recovery of Nickel. V. 66, No. 729, January 1973, p. 140.

[9] Wood, J. Armco Details Cost Advantage, Toughness of Nickell Alloy. Am. Metal Market, v. 79, No. 180, Oct. 2, 1972, p. 27.

Nitrogen

By Ted C. Briggs [1]

Domestic production of fixed nitrogen increased by 2%, while production of elemental nitrogen increased by 15% in 1972. Domestic ammonia plants produced at about 84% of their total capacity.

Farmland Industries, Inc., announced plans to build an ammonia plant near Enid, Okla.

Exports of major nitrogen compounds surged upward in 1972, with a 31% increase above 1971 exports and an $81 million increase in value of the exports. There was little overall change in total imports. A large increase in urea imports was partially offset by a sharp drop in imports of sodium nitrate.

[1] Chemist, Division of Nonmetallic Minerals.

Table 1.—Salient nitrogen statistics

(Thousand short tons of contained nitrogen)

	1968	1969	1970	1971	1972 p
United States:					
Production as ammonia	10,130	10,664	11,516	11,673	11,901
Production as nitrogen gas	4,302	4,807	5,477	6,087	7,011
Exports of nitrogen compounds [1]	1,428	1,645	1,400	999	1,310
Imports for consumption of nitrogen compounds [1]	669	738	942	907	947
Consumption [1]	9,682	9,939	10,876	11,469	11,583
World: Production [1]	35,427	39,556	42,747	45,357	47,398

p Preliminary.
[1] Estimated, excludes nitrogen gas.

Table 2.—Nitrogen production in the United States

(Thousand short tons of contained nitrogen)

	1968	1969	1970	1971	1972 p
Anhydrous ammonia: Synthetic plants [1]	9,968	10,502	r 11,369	11,538	11,762
Ammonia compounds, coking plants:					
Ammonia liquor	14	12	12	12	11
Ammonium sulfate	142	143	126	114	128
Ammonium phosphates	6	7	9	9	(2)
Total	10,130	10,664	r 11,516	11,673	11,901
Nitrogen gas [1]	4,302	4,807	5,477	6,087	7,011

p Preliminary.
[1] Bureau of the Census Current Industrial Reports.
[2] Included with ammonium sulfate to avoid disclosing individual company data.

Table 3.—Major nitrogen compounds produced in the United States

(Thousand short tons, gross weight)

Compounds	1971	1972
Acrylonitrile	--	557
Ammonium nitrate	6,605	6,872
Ammonium sulfate [1]	2,361	2,471
Ammonium phosphates	5,891	6,499
Nitric acid	6,742	7,022
Urea	3,071	3,510

[1] Includes ammonium sulfate from coking plants.

Sources: Bureau of the Census and Tariff Commission.

DOMESTIC PRODUCTION

Production of fixed nitrogen increased by 2% in 1972, but this percentage should be viewed with caution since final production figures have, in general, been revised upward at later dates. About 33,000 standard cubic feet of natural gas was required to produce 1 ton of anhydrous ammonia; therefore, about 470 billion standard cubic feet of natural gas was used to produce synthetic ammonia in 1972. The production of ammonia accounted for roughly 2% of the domestic consumption of natural gas. Domestic ammonia plants produced at about 84% of the total maximum domestic capacity, up from 81% of capacity in 1971. All of the domestic plants combined will probably have difficulties producing at a combined rate much over 90% of capacity. It can be seen, therefore, that production moved toward effective capacity during 1972. The production of elemental nitrogen jumped by 15% in 1972.

Farmland Industries, Inc., announced plans to build an ammonia plant near Enid, Okla. Capacity was scheduled to be 380,000 tons per year when the plant comes onstream in 1974, and natural gas feedstock for the plant was to be supplied by Oklahoma Natural Gas Co. Mid-America Pipeline Co., Inc. (MAPCO) planned to construct a 6-inch-diameter pipeline, 115 miles in length, from the Farmland Industries plant to MAPCO's existing ammonia pipeline southwest of Hutchinson, Kans. Farmland Industries also announced plans to construct 30,000-ton ammonia storage terminals in Nebraska, Iowa, and Minnesota. Total cost of the Farmland Industries project was expected to exceed $30 million.[2]

CF Industries, Inc. was planning to build a 1,000-ton-per-day urea plant at its Donaldsonville, La., nitrogen complex where the company now operates two 1,000-ton-per-day ammonia plants. Also, the company planned to add regional warehouses for urea at four locations, with a total capacity of 100,000 tons.

Later in the year, property owners adjacent to the proposed urea plant location took legal steps to enjoin construction of the plant on the basis of possible noise from the plant, the visual appearance of the plant, and possible emissions. No disposition of the dispute had been made at yearend.[3]

Shell Chemical Co. planned to drop out of the fertilizer production business with the closures of its ammonia and nitrogen products plants at Ventura, Calif., and St. Helens, Oreg. Reasons given for the closures were an oversupply of ammonia, spiraling operating cost, technological obsolescence and small production capacity of the plants, and shortage of natural gas feedstock. Later, Shell reached a tentative agreement with Reichhold Chemicals, Inc. for Reichhold to purchase the St. Helens, Oreg., facilities. Production capacity at St. Helens was 80,000 tons per year of ammonia and 50,000 tons per year of urea.[4]

Vicksburg Chemical Corp. planned to reopen the potassium nitrate plant formerly owned and operated at Vicksburg, Miss., by American Metal Climax, Inc. (AMAX).[5]

Air Products & Chemicals, Inc., filed a legal action against United Gas Pipe Line Co. Air Products was seeking a declaratory judgment limiting the prices to be charged under a long-term natural gas supply contract. An injunction was also being sought to assure continued natural gas service while the matter was in litigation. United Gas supplied natural gas feedstock to Air Products' Escambia, Fla., plant which produced ammonia, methanol, and other industrial chemicals.[6]

American Cyanamid Co. discontinued its sales of high explosives, blasting caps, and related products. Low profit margins, a declining market, and rising cost of distribution and security were cited as reasons for the decision. The company planned to continue to sell ammonium nitrate for agricultural and blasting agent uses.[7]

---

[2] Chemical Marketing Reporter. Ammonia by Pipeline Project Set by Mapco. V. 201, No. 25, June 19, 1972, p. 4.
———. Farmland Industries Schedules NH_3 Facility. V. 201, No. 26, June 26, 1972, p. 5.

[3] Chemical Marketing Reporter. CF Industries Is Planning $65 Million Fertilizer Project. V. 202, No. 5, July 31, 1972, p. 3.
Chemical Week. Urea: A Noisy Subject. V. 111, No. 23, Dec. 6, 1972, p. 16.

[4] European Chemical News. Reichhold To Buy Shell N, Urea Units. V. 22, No. 553, Oct. 6, 1972, p. 6.
Farm Chemicals & Croplife. News Report. V. 135, No. 6, June 1972, p. 40.

[5] Chemical Week. Technology Newsletter. V. 111, No. 4, July 26, 1972, p. 59.

[6] Chemical Marketing Reporter. Air Products Suing United On Gas For Methanol, NH_3. V. 202, No. 25, Dec. 18, 1972, p. 3.

[7] Chemical Marketing Reporter. American Cyanamid Drops High Explosives Marketing. V. 201, No. 16, Apr. 17, 1972, p. 16.

Gulf Central Storage and Terminal Co. announced plans to build four refrigerated storage tanks for anhydrous ammonia. The tanks will be located at Iowa Falls and Algona, Iowa; Aurora, Nebr., and Crawfordsville, Ind., and each tank will have a capacity of 30,000 tons. Five additional pump stations were to be added in the Gulf Central pipeline system.[8]

[8] Farm Chemicals & Croplife. Coming: More NH_3 Storage. V. 135, No. 3, March 1972, p. 62.

Table 4.—Domestic producers of ammonium nitrate

(Thousand short tons per year of NH_4NO_3)

Company	Location	Capacity
Agway, Inc	Olean, N.Y	69
Air Products & Chemicals Inc	Pace Junction, Fla	100
Allied Chemical Corp	Geismar, La	174
Do	Hopewell, Va	287
Do	La Platte, Nebr	100
Do	South Point, Ohio	100
American Cyanamid Co	Hannibal, Mo	132
Apache Powder Co	Benson, Ariz	66
Arkla Chemical Corp	Helena, Ark	96
Atlas Chemical Industries, Inc	Joplin, Mo	233
Do	Tamaqua, Pa	40
Carolina Nitrogen Corp	Wilmington, N.C	188
CF Industries, Inc	Fremont, Nebr	32
Central Nitrogen, Inc	Terre Haute, Ind	132
Cherokee Nitrogen, Inc	Pryor, Okla	85
Chevron Chemical Co	Richmond, Calif	41
Do	Fort Madison, Iowa	78
Do	Kennewick, Wash	83
Collier Carbon & Chemical Corp	Brea, Calif	60
Do	Kennewick, Wash	100
Columbia Nitrogen Corp	Augusta, Ga	208
Cominco-American Ltd	Beatrice, Nebr	149
Commercial Solvents Corp	Sterlington, La	187
Do	Marion, Ill	40
Cooperative Farm Chemical Assn	Lawrence, Kans	270
Farmers Chemical Co	Tunis, N.C	165
Do	Tyner, Tenn	165
Gulf Oil Corp	Pittsburg, Kans	360
Do	Henderson, Ky	112
Hawkeye Chemical Co	Clinton, Iowa	147
Hercules, Inc	Hercules, Calif	80
Do	Louisiana, Mo	460
Do	Donora, Pa	137
Illinois Nitrogen Co	Marseilles, Ill	99
Kaiser Agricultural Chemicals Co	Savannah, Ga	198
Do	Tampa, Fla	54
Do	North Bend, Ohio	96
Do	Bainbridge, Ga	48
Miscoa	Yazoo City, Miss	330
Mobil Chemical Co	Beaumont, Tex	177
Monsanto Co	Luling, La	275
Do	El Dorado, Ark	350
Nipak, Inc	Kerens, Tex	51
Nitram, Inc	Tampa, Fla	132
Phillips Pacific Chemical Co	Kennewick, Wash	50
Phillips Petroleum Co	Beatrice, Nebr	68
Do	Etter, Tex	168
Do	Pasadena, Tex	16
St. Paul Ammonia Products Co	Pine Bend, Minn	88
Shell Chemical Co	St. Helens, Oreg	22
Do	Ventura, Calif	24
Terra Chemicals International	Port Neal, Iowa	137
USS Agri-Chemicals, Inc	Cherokee, Ala	90
Do	Geneva, Utah	100
Do	Crystal City, Mo	92
Valley Nitrogen Producers, Inc	El Centro, Calif	41
Vistron Corp	Lima, Ohio	75
Wycon Chemical Co	Cheyenne, Wyo	75
Subtotal		7,532
Undesignated		380
Total		7,912

Source: Tennessee Valley Authority.

CONSUMPTION AND USES

The principal end use for fixed nitrogen materials in 1972 was, as usual, for fertilizers. Fertilizer usage accounted for about 74% of the domestic fixed nitrogen consumption. Environmentalists and ecologists continued their efforts to limit the use of nitrogen fertilizers, but various other studies have found no evidence of danger to man, animals, or the global environment from present patterns of nitrogen fertilizer usage. Also, the Illinois Pollution Control Board, after nearly a year of public hearings, rejected attempts to severely curtail fertilizer usage.[9]

One very important, but rarely mentioned, class of nitrogen compounds was the surface-active agents. The basic chemicals are primary amines obtained when fatty acids are reacted with ammonia. The largest single use of these materials was for fabric softeners. Another important use of surface-active agents was in herbicides and insecticides in order to make the pesticides cling to the plants and prevent them from being washed away by rain or dew. Surface-active agents were used in agriculture as anticaking agents in fertilizers. The amount of surface-active agents required to impart anticaking properties was small, approximately 0.5 weight-percent.

In the textile industry, the nitrogen-containing surface-active agents were used in the formulation of antistatic spinning oils, as softeners, as dye-leveling and retarding agents, and as dye fixatives. In the bituminous road construction industry, surface-active agents were used as adhesion agents to prevent a water barrier from forming when the hot bitumen comes into contact with stone surfaces during road construction.

Surface-active agents were used extensively in mineral ore beneficiation. The first big industrial application of aliphatic amine salts was for the flotation of potash. Amines have a peculiarly strong affinity to any form of silicon surfaces, and amine collectors were used for the enrichment of silica sand for glass factories. Also, amines were used to produce a high-quality white clay for paper coating, and were used to remove silica from iron ore. In the petroleum industry, surface-active agents were used in drilling fluids, as corrosion inhibitors, as de-icers and antistalling agents in gasoline, in diesel and domestic fuel oils to inhibit oxidation and polymerization, as acid scavengers, and to keep small solid particles in suspension.[10]

Under pressure from some members of Congress and from consumer advocates, the Food and Drug Administration (FDA) placed mild restrictions on the use of sodium nitrite as a food additive. Sodium nitrates and sodium nitrites have been used for many years as food additives to prevent red meat from turning brown, to impart the red color to cured meats, and to retard development of the microorganism clostridium botulinum which, when it grows in food and is ingested, becomes an acute food poison marked by a high mortality rate. The criticism of sodium nitrite usage as a food additive resulted from some scientific data that indicated the sodium nitrite could react with secondary and tertiary amines under certain conditions to form some nitrosamines that have been found to be carcinogenic in test animals. The FDA thus had the difficult choice between a possible risk of cancer or the very real hazard of botulism. The new restrictions remove the chemical from food uses which were deemed nonessential.[11]

---

[9] Agricultural Chemicals & Commercial Fertilizers. Attempts To Severely Curtail Fertilizer Use Rejected by Illinois Pollution Board. V. 27, No. 5, May 1972, pp. 11–14.
———. Commoner Points the Finger at Nitrogen. V. 27, No. 3, March 1972, p. 3.
Chemical & Engineering News. Controversy Builds Over Fertilizer Runoff. V. 50, No. 2, Jan. 10, 1972, pp. 17–18.
Chemical Marketing Reporter. Fertilizer Use Could Be Boosted Without Hurting Ecology: USDA Man. V. 201, No. 7, Feb. 14, 1972, pp. 5, 47.
———. Nitrate Hazards. V. 202, No. 10, Sept. 4, 1972, p. 9.
Farm Chemicals & Croplife. Commoner Gets a Fertilizer Lesson. V. 135, No. 1, January 1972, pp. 32–34.
———. It's Time to Speak Out. V. 135, No. 2, February 1972, pp. 14–15.
National Academy of Sciences. Accumulation of Nitrate. Washington, D.C., 1972, 106 pp.
Pratt, P. F. Nitrate in the Unsaturated Zone Under Agricultural Lands. U.S. Environmental Protection Agency, Water Pollution Control Research Series No. 16060 DOE, April 1972, 45 pp.
Wolf, I. A., and A. E. Wasserman. Nitrates, Nitrites, and Nitrosamines. Science, v. 176, No. 4043, July 7, 1972, pp. 15–20.

[10] Schwitzer, M. K. The Application of Cationic Surface Active Agents. Chem. and Ind. (London), No. 21, Nov. 4, 1972, pp. 822–831.

[11] Chemical Marketing Reporter. Nitrites, Nitrates Reprieved as FDA Devises Compromise; Anti-Botulism Property Cited. V. 202, No. 20, Nov. 13, 1972, pp. 7, 18.
Chemical Week. Accord on Nitrites. V. 111, No. 21, Nov. 22, 1972, p. 27.

PRICES

In general, prices of major nitrogen compounds increased or, in some instances, remained stable during 1972. The following are samples of pricing actions during 1972.

Vistron Corp.'s price for agricultural ammonia was set at $59.40 per ton on April 1, 1972, for ammonia delivered to all States east of the Continental Divide, except Montana, New York, Pennsylvania, Maryland, New Jersey, West Virginia, North Carolina, South Carolina, Virginia, and the New England States. For roughly the same geographical area, W. R. Grace & Co. and Wycon Chemical Co. set the delivered tankcar price for ammonia of $60 per ton into effect on February 1, while Olin Corp. established a listing of $57 per ton, same basis.

Vistron Corp.'s prices for low-pressure nitrogen solution (37% nitrogen, in tankcar lots) was set at $120 per ton of contained nitrogen or $44.40 per ton of product, f.o.b. Lima, Ohio, freight equalized against the delivered cost of the same solution shipped from approved competitive shipping points.

American Cyanamid Co. set new schedules, effective July 1, 1972, for ammonium nitrate fertilizer. The bulk price of ammonium nitrate prills to fertilizer manufacturers was set at $45 per ton f.o.b. South River, Mo. The delivered price in bulk 50-ton carlots was $47 per ton. Generally the delivered price applied to customers in the Midwest and South. A delivered price of $51 per ton was quoted for bulk material in 50-ton carlots from Port Robinson, Ontario, Canada, and applied to customers in New England, the East, and the Southeast. Monsanto Chemical Co. announced similar prices for ammonium nitrate.

W. R. Grace & Co. announced a price for direct application anhydrous ammonia of $60 per ton on August 1, 1972, the price included delivery by truck or rail to the New England States, New York, New Jersey, Pennsylvania, Maryland, West Virginia, Virginia, North Carolina, and South Carolina. Delivered prices in States east of the Continental Divide, excluding Montana, Georgia, Florida, and the other States previously listed, was $55 per ton. Announced price for urea (45% nitrogen) was $58 per ton f.o.b. Woodstock, Tenn. Delivered price for urea in 50-ton carlots was $61 per ton, while minimum car and trucklots were set at $65 per ton. Urea (46% nitrogen) was $2 per ton higher.

Vicksburg Chemical Co. announced delivered bulk prices from $91 to $103 per ton, depending on the delivery zone, for potassium nitrate. Prilled material was $4 per ton higher and an additional $8.50 per ton was charged for material packaged in bags of 100-pound capacity.

H. J. Baker & Bro., Inc., issued a new price list, effective July 7, 1972, for its po-

Table 5.—Price quotations for major nitrogen compounds in 1972

(Per short ton)

Compound	Jan. 1	Dec. 25
Ammonium nitrate, domestic, fertilizer-grade, 33.5% nitrogen, bulk, delivered	$47–$49	$47–$49
80-pound bags, same basis	47–54	47–54
Ammonium sulfate, standard-grade, commercial, bulk, f.o.b. works	[1] 15–27	--
Anhydrous ammonia, fertilizer, wholesale, tanks, delivered east of Rockies, except East Coast	55–65	55–65
Aqueous ammonia, 29.4% NH_3, anhydrous basis, tanks, freight equalized, east of Rockies	65–70	65–70
Delivered east coast	60–65	60–65
Sodium nitrate, domestic, agricultural, bulk, carlots, f.o.b. works	51.50	51.50
Bags, carlots, f.o.b. works	55.50	55.50
Sodium nitrate, imported, commercial, bulk, carlots, f.o.b. Atlantic and Gulf warehouses	51.50	51.50
100-pound bags, carlot, same basis	55.50	55.50
Urea:		
Industrial, 46% nitrogen, bulk, 50-ton carlots, delivered East	64–76	64–76
Agricultural, 46% nitrogen, bulk, same basis	62–63	62–63
Agricultural, 45% nitrogen, bulk, 50-ton carlots, delivered East	60–61	60–61
Diammonium phosphate, fertilizer grade, 18–46–0, bulk, carlots, f.o.b. Florida works	55–66	55–66
Bags, same basis	61–73.50	61–73.50

[1] Chemical Marketing Reporter. Agricultural Chemicals. V. 201, No. 21, June 5, 1972, p. 23.

Source: Chemical Marketing Reporter.

tassium nitrate which was imported from Israel. Bulk price was set at $87 per ton f.o.b. cars and trucks at warehouse. Prilled material was priced at $91 per ton with a charge of $8.50 per ton extra for bagged material.

Hooker Chemical Corp. announced new prices for anhydrous ammonia of $67 per ton f.o.b. its Tacoma, Wash., plant with freight allowed to destinations in the States of Washington and Oregon and west of the Cascade Mountains. The prices were for agricultural and industrial consumers (except for the paper and pulp industry).[12]

Urea prices firmed during the year because of increased consumption and, in part, because of the closures of a 250,000-ton-per-year plant of E. I. du Pont de Nemours & Co. and a 190,000-ton-per-year plant of Allied Chemical Corp.[13]

FOREIGN TRADE

Exports of major nitrogen compounds surged upward in 1972, with a 31% increase in the total amount of contained nitrogen exported and an $81 million increase in value of the exports. Increased exports were due to the effects of devaluation of the dollar, strong international demand and prices for nitrogenous fertilizers, domestic price ceilings, and technical problems which delayed the startup of new ammonia plants in several areas of the world. Exports are expected to decline as domestic demand moves into balance with domestic capacity.

On a contained nitrogen basis, total imports increased by only 4%. The most significant changes in the import pattern were a 70% increase in urea imports and a 44% drop in sodium nitrate imports.

[12] Chemical Marketing Reporter. Agricultural Chemicals. Agricultural Nutrients. V. 201, No. 15, Apr. 10, 1972, p. 17; v. 202, No. 1, July 3, 1972, p. 16; v. 202, No. 3, July 17, 1972, p. 23; v. 202, No. 6, Aug. 7, 1972, p. 21; v. 202, No. 7, Aug. 14, 1972, p. 22; v. 202, No. 21, Nov. 20, 1972, p. 31.

[13] European Chemical News. U.S. Urea Prices Firm. V. 22, No. 542, July 21, 1972, p. 4.

Table 6.—U.S. exports and imports for consumption of major nitrogen compounds

(Thousand short tons and thousand dollars)

Compound	1971			1972		
	Gross weight	Nitrogen content e	Value	Gross weight	Nitrogen content e	Value
EXPORTS						
Industrial chemicals: Anhydrous ammonia and chemical grade aqua (ammonia content)	56	46	2,391	161	132	4,943
Fertilizer materials:						
Ammonium nitrate	39	13	2,236	22	7	1,183
Ammonium phosphates	1,357	244	72,384	1,816	327	126,046
Ammonium sulfate	516	r 106	7,255	520	107	14,006
Anhydrous ammonia and aqua (ammonia content)	440	361	13,888	551	452	17,001
Nitrogenous chemical materials, n.e.c.	90	27	8,656	66	20	6,171
Sodium nitrate	1	(1)	76	1	(1)	74
Urea	392	r 178	19,180	500	228	25,298
Mixed chemical fertilizers	235	r 24	15,315	367	37	27,719
Total	3,126	r 999	141,381	4,004	1,310	222,441
IMPORTS						
Industrial chemicals: Ammonium nitrate	3	(1)	212	5	2	250
Fertilizer materials:						
Ammonium nitrate	374	125	16,106	378	127	16,576
Ammonium nitrate-limestone mixtures	(1)	(1)	2	(1)	(1)	13
Ammonium phosphates	457	r 82	28,018	501	90	31,070
Ammonium sulfate	229	r 47	5,060	264	54	7,310
Calcium cyanamide or lime nitrogen	5	1	523	3	(1)	312
Calcium nitrate	40	6	982	47	7	1,092
Nitrogen solutions	168	50	5,523	149	45	4,763
Anhydrous ammonia	462	379	20,426	386	317	17,001
Potassium nitrate or saltpeter, crude	22	3	1,421	21	3	1,673
Potassium nitrate, sodium nitrate mixtures	61	9	2,651	28	4	1,447
Sodium nitrate	203	32	6,917	111	18	3,865
Urea	328	r 149	16,114	556	253	25,565
Nitrogenous fertilizers, n.s.p.f.	21	4	1,227	34	7	1,710
Mixed chemical fertilizers	200	r 20	13,099	200	20	12,390
Total	2,573	r 907	118,281	2,683	947	125,037

e Estimated. r Revised.

1 Less than ½ unit.

WORLD REVIEW

The most significant development in the world market for nitrogenous fertilizers was the change from a large oversupply situation at the beginning of the year to a market with increasing prices and localized shortages of some types of fertilizers by yearend. While world production of fixed nitrogen did not increase dramatically, there was a significant reduction in stocks of nitrogenous fertilizers carried over from the previous year. A factor which contributed to tight supplies in some areas was a rather widespread malfunctioning of new ammonia plants that were scheduled to come onstream during the year.

Eastern Europe consolidated its position as the world's leading area for the production of fixed nitrogen, and the People's Republic of China, and India continued to be the world's leading importing countries with combined imports of 35% of the nitrogenous fertilizers traded in the international markets.[14]

Australia.—Austral-Pacific Fertilizers Ltd. merged with Eastern Nitrogen Ltd. into Consolidated Fertilisers Ltd. Shareholders in the new firm were Imperial Chemical Industries of Australia & New Zealand Ltd. (ICI Australia) with 37.7%, The Dow Chemical Co. with 19.8%, Swift and Co. with 13%, Sulphide Corp., which was a subsidiary of Conzinc Rio Tinto Australia Ltd., with 9%, King Ranch Australia with 3.9%, Mitsui & Co. with 2.3%, and others with 14.3%. The consolidated group faced the basic problem that Australia had about twice as much fertilizer capacity as the domestic market could absorb.[15]

Brazil.—Ammonia production in Brazil was based mainly in the central and northern sectors. There were two plants in Cubatao, São Paulo. One of these started production in 1959 and had a capacity of about 10,000 tons per year. This plant used refinery gas as a feedstock. The other plant started production in 1970 with a capacity of 120,000 tons per year while using naphtha as the feedstock. A third plant at Camacari, Bahia, had a capacity of 47,000 tons per year with production starting in 1971. Brazilian production cost did not, however, allow domestic ammonia to compete very well with imported ammonia. For example, imported ammonia was available at $50 per ton, while domestic ammonia sold for $90 per ton.[16]

Canada.—DuPont of Canada, Ltd. began construction of a commercial explosives plant at Ashcroft, British Columbia. The plant, estimated to cost $4 million, was expected to be onstream in 1973. The plant will produce newly developed explosive products.[17]

Chile.—A new grade of Chilean potash nitrate was introduced. The new product had an analysis of 15% N, 14% K_2O equivalent, and 18% Na. Price of the new grade was adjusted to take account of the additional value, but price per unit of plant food remained unchanged.[18]

Czechoslovakia.—A 1,000-ton-per-day ammonia synthesis unit and a 15,000-ton ammonia storage unit were delivered by Friedrich Uhde G.m.b.H. of Dortmund, West Germany, to the Duslo plant, of Sala, Nad Vahom. The delivery included six compressors designed by the Swedish company Stal Refrigeration AB, of Norrkoping.[19]

A 200,000-ton-per-year urea plant at Zaluzi near Most in Czechoslovakia was expected to start production at midyear.[20]

A 300,000-ton-per-year fertilizer granulation plant was to be built at Bratislava, by French engineering companies. Ammonia, ammonium nitrate solution, urea, and superphosphate were to be brought in by rail.[21]

Finland.—Typpi Oy, the country's nitrogenous fertilizer producer, operated state-owned plants for the production of ammonia, urea, nitric acid, and compound fertilizers. Plants are located at Oulu near the head of the Gulf of Bothnia in northern Finland. The ammonia plant was said to be the most northerly in the world.

---

[14] Nitrogen (London). World Trends. No. 80, November–December 1972, pp. 5–7.

[15] European Chemical News. Consolidated Fertilizers Quantifies Losses. V. 21, No. 523, Mar. 10, 1972, p. 30. Feed & Farm Supplies. Australia's Fertilisers Brighten. V. 69, No. 10, Oct. 1972, p. 25.

[16] Chemical Age. Perspective. V. 104, No. 2744, Feb. 18, 1972, p. 11.

[17] European Chemical News. Explosives for DuPont. V. 22, No. 561, Dec. 1, 1972, p. 12.

[18] Feed & Farm Supplies. More Potash in Chilean Potash Nitrate. V. 69, No. 12, December 1972, p. 30.

[19] Chemical Age. Uhde Ammonia Plant Delivered to Czechoslovakia. V. 104, No. 2742, Feb. 4, 1972, p. 19.

[20] European Chemical News. Czechoslovak Urea Unit Nears Completion. V. 21, No. 518, Feb. 4, 1972, p. 8.

[21] European Chemical News. Kaltenbach Wins Bratislava NPK Order. V. 21, No. 528, Apr. 14, 1972, p. 16.

Ammonia capacity was 1,000 tons per day and the plant was designed by Humphrey's & Glasgow of the United Kingdom. Another older ammonia plant was converted for methanol production. Part of the ammonia production was converted to urea in a plant with a capacity of 100,000 tons per year.

A large export market for Finnish urea was the People's Republic of China.

Typpi Oy produced a high-analysis compound fertilizer by digesting low-grade phosphate rock with nitric acid and extracting the resulting fertilizer material with tertiary amyl alcohol.[22]

France.—An air separation plant with a capacity of 1,400 tons per day of nitrogen was brought onstream by l'Air Liquide at Fos-sur-Mer, near Marseille. Nitrogen production was divided into 340 tons per day of high-purity nitrogen, 940 tons per day of 99% purity nitrogen, and 120 tons per day of liquid nitrogen.[23]

A nitric-acid-based fertilizer complex was started at Montoir-de-Bretagne near St. Nazaire. The plant was to produce 600 tons per day of ammonium nitrate, 150 to 200 tons per day of compound granulated fertilizers, and 30,000 tons per year of liquid fertilizers.[24]

Germany, East.—The East German Industrie Import Anlagen signed a contract with the Polish trade organization, Budinex, for the planning and construction of an oil pipeline to link the East German petrochemical complexes at Schwedt and Leuna. Leuna was the traditional center of East German nitrogen production which supplied over 500,000 tons per year of ammonia. The most significant development at Leuna was the gradual conversion of ammonia plants to petroleum feedstock. Previously all of the ammonia units at Leuna were based on lignite supplied from nearby coal workings. Schwedt was also an important center for the production of fertilizers, and gases from a large petroleum refinery located there were used as feedstock for ammonia production.[25]

Germany, West.—Domestic consumption of nitrogenous fertilizers increased while domestic production and exports declined. Imports of ammonium nitrate, ammonium sulfate, and urea supplied the 4% increase in domestic consumption. The bulk of the imports came from East European countries and sold at prices 3% or 4% below the domestic prices. Exports of nitrogenous fertilizers declined; consequently production was expected to drop, with some production units operating at 70% of capacity or less.[26]

Greece.—The fertilizer plant at Ptolemais of Nitrogenous Fertilisers Industry S.A. was to expand its capacity by the installation of units with capacities of 580 tons per day of ammonium sulfate, 440 tons per day of ammonium nitrate, and 230 tons per day of nitric acid.[27]

A battle took place through the Greek press over the decision of the state-owned Nitrogenous Fertilisers Industry S.A. to expand its lignite-based ammonia facilities. In a series of open letters to the Prime Minister in the Athens Daily Post, an opponent of the project called for a reassessment because he claimed the method for producing ammonia from lignite was outdated and economically unjustifiable.

In reply to arguments against the project, the Board of Directors of the Nitrogenous Fertilisers Industry issued a lengthy statement in the same newspaper. The Board of Directors said that the plants were a national industry of public utility, a medium of application of rural policy of the Government, and not an enterprise in which the state expected some short-term profits. Also, the Board stated that the exploitation of local lignite was a national duty. Greece, lacking sources of liquid fuels and natural gas, had based its policies on the utilization of local resources and was continuing to follow this policy despite high investment cost.[28]

India.—The Indian Government's crash program to raise an additional 16.5 million tons of grain aggravated the Nation's chronic fertilizer shortage. Meeting the grain quota added 480,000 tons to India's nitrogen fertilizer requirements.

---

[22] European Chemical News. Finland Launches Massive Growth In Petrochemicals. V. 21, No. 514, Jan. 7, 1972, pp. 16–20.

[23] European Chemical News. L'Air Liquide Starts O_2 Unit at Fos. V. 22, No. 559, Nov. 17, 1972, p. 8.

[24] Chemical Age. Gardiloire Large Fertiliser Complex Starts Up. V. 104, No. 2751, Apr. 7, 1972, p. 15.

[25] European Chemical News. Poland To Build Second Schwedt-Leuna Link. V. 22, No. 541, July 14, 1972, p. 10.

[26] European Chemical News. Germany Fails To Stem Fertilizer Import Flood. V. 22, No. 536, June 9, 1972, p. 8.

[27] Chemical Age International. Ptolemais Order Further Uhde Fertiliser Units. V. 104, No. 2763, June 30, 1972, p. 18.

[28] European Chemical News. AEBEL Defends Ammonia-From-Lignite. V. 21, No. 514, Jan. 7, 1972, p. 12.

For future fertilizer supplies, India signed contracts with foreign producers and planned expansions of domestic fertilizer plants. A $14.4 million contract was signed with the Japan Ammonium Sulphate & Urea Export Co. Ltd. for 200,000 tons of urea. Contracts were signed for 460,000 tons of urea from Bulgaria for future delivery, and negotiations were underway with Kuwait for 350,000 to 500,000 tons of urea and 250,000 tons of liquid ammonia.

Mangalore Chemicals and Fertilizers started construction of an $80 million ammonia and urea complex based on naphtha feed stock. The plant location is at Panambur, in Mysore State, in southern India, and Mangalore had been licensed to produce 220,000 tons per year of ammonia and 340,000 tons per year of urea.

Also, India was shopping in the Soviet Union and Czechoslovakia for equipment for coal-based fertilizer projects planned for Korba, Talcher, and Ramagundam. An Indian technical team returned empty-handed from an earlier shopping trip to the United States, Western Europe, and Japan.[29]

The Indian Ministry of Petroleum and Chemicals continued to put forward optimistic plans for future fertilizer production, and plans were presented to double nitrogen fertilizer capacity by 1979. India hoped to achieve self-sufficiency in nitrogen fertilizers by 1977, but, historically, earlier plans have failed to meet stated goals. For example, a capacity to produce 3 million tons of nitrogen in fertilizers by 1974 was planned, but only 2.3 million tons of nitrogen capacity now seem possible and actual capacity may be below this amount.

At the beginning of the "Fourth Plan" nitrogen capacity was just over 1 million tons per year. Capacity was increased to 1.34 million tons per year in 1970–71, and during 1971–72 two new ammonia plants went into production which, together, increased capacity to 1.53 million tons per year.

The ministry pointed out that if its assumptions prove to be invalid, then production will be set back. The supply of power at Nongal was one important factor which was assumed. A second assumption was that production would not suffer because of labor problems.[30]

Indonesia.—P. T. Pupuk Sriwidjaja, Indonesia's Government-owned petrochemical company, selected M. W. Kellogg Co. as general contractor for the major portion of an $84 million fertilizer and petrochemical complex to be built on the Musi River near Palembang, in southern Sumatra. Kellogg will have responsibility for the erection of all process and offsite facilities except for gas gathering and transmission.

The plans called for the erection of a 660-ton-per-day ammonia plant which Kellogg will design and engineer, and a 1,150-ton-per-day urea plant using the design of Mitsui Toatsu Co. which will be engineered by Toyo Engineering Co. of Japan. The plant will use 42 million standard cubic feet per day of natural gas feedstock, which will be piped approximately 70 miles from Sumatran natural gasfields.[31]

Ireland.—Nitrogin Eireann Teorata of Ireland awarded a contract in excess of $2.6 million for the expansion of its calcium ammonium nitrate facilities at Arklow, County Wicklow. Woodall-Duckham Ltd., of the United Kingdom, was the selected contractor and the Kaltenback process was to be used. Plant capacity will be 150,000 tons per year.[32]

Italy.—A subsidiary of Italy's state-owned energy group brought onstream one of the largest ammonia and urea complexes in the world. Ammonia capacity was 1,500 tons per day, and urea capacity was 1,100 tons per day. The site of the new plants was at Monfredonia in the Mezzogiorno, Italy's southern development area. Because the complex is located in an area with scarce water supplies, extensive use was made of air coolers and condensers.[33]

Japan.—Signs pointed, for the first time in 5 years, to an improved outlook for Japan's chemical fertilizer industry, mainly because of improvements in exports. The Japan Ammonium Sulphate & Urea Export Co. Ltd. reported that, at the end of the fertilizer year, the country's two most important chemical fertilizers, ammonium sul-

[29] Chemical Week. Indian Fertilizer Gap Gets Wider. V. 111, No. 16, Oct. 18, 1972, p. 43.
[30] European Chemical News. Indian N Fertilizer Plan Optimistic. V. 22, No. 540, July 7, 1972, p. 16.
[31] Chemical Marketing Reporter. Ammonia, Urea Project Is Slated for Indonesia. V. 200, No. 20, Dec. 20, 1971, p. 7.
[32] Chemical Marketing Reporter. Ammonium Nitrate Project. V. 201, No. 19, May 8, 1972, p. 7.
[33] Chemical Marketing Reporter. Ammonia-Urea Facility Is Opened by Italy's ANIC. V. 202, No. 26, Dec. 25, 1972, p. 3.

fate and urea, had stockpile reductions of 300,000 and 550,000 tons, respectively. The reduction in stocks was due to unexpected growth in demand for fertilizers in India, Mexico, and other countries in Southeast Asia and Latin America.[34]

The Japan Ministry of Trade and Industry (MITI) urged Japanese fertilizer producers to make a gradual retreat from world fertilizer export markets. While acknowledging Japan's current share of the fertilizer export markets, MITI had strong doubts about the long-term prospects in this sector. MITI predicted that ammonia demand would grow only slightly and that existing Japanese ammonia plants will only be operating at 86% of capacity in 1976. Old plants should be closed and no new capacity was necessary according to MITI. MITI said that around 770,000 tons per year of urea capacity should be scrapped to reduce the current 70% to 80% dependence on export markets.[35]

Mitsubishi Katoki Kaisha commissioned a large coal gas distillation plant at the Sakaidi, Kanagawa complex of Mitsubishi Chemical Industries. The new plant employed U.S. Steel Corp.'s Phosam ammonia recovery process which separated ammonia, benzene, and fuel gas from coal gas.[36]

Japanese producers of caprolactam, coke, and synthetic resins started moves to cut back production of byproduct ammonium sulfate by introducing new processes. Nearly all Japan's ammonium sulfate was produced as byproduct material, and in 1972 production of byproduct ammonium sulfate was over 2 million tons.

Ube Industries Ltd., Japan's largest producer of caprolactam, planned to use Dutch State Mines technology to reduce ammonium sulfate production from 4.2 tons to 1.7 tons per ton of caprolactam produced.

Mitsubishi Chemical Industries and Nippon Steel Corp. adopted new coke production processes which do not produce ammonium sulfate. Also, Mitsubishi Chemical Industries applied for a loan to finance a new methyl methacrylate unit to cut byproduct ammonium sulfate production.[37]

Japan's fertilizer industry enjoyed a sharp rise in demand and price improvements after 3 sluggish years. Orders and inquiries were received from Mexico, El Salvador, India, Brazil, China, and other countries. Japanese fertilizer producers rejected a number of inquiries because the prices proposed by potential buyers were considered too low. In the past, about 60% of Japan's fertilizer exports went to China.[38]

Mexico.—A joint venture group consisting of Celanese Mexicana, Nylon de Mexico, Dutch State Mines, and the Credits Buratil of the Mexican bank commissioned its 40,000-ton-per-year caprolactam plant at Salamanca, Mexico. Dutch State Mines, which holds a 23% interest in the operation, supplied the plant process, and construction was carried out by Stamicarbon Corp. The plant was to provide a domestic source of caprolactam for the nylon operations of Celanese Mexicana at Taluca and Nylon de Mexico at Monterrey. Fibras Sinteticas, which recently expanded its nylon polymerization and spinning facilities at Monterrey with the aid of Vickers Zimmer, was also expected to take caprolactam from the new plant. Ammonia and cyclohexane for the new operation were supplied by Petróleos Mexicanos (Pemex) and the byproduct ammonium sulfate produced along with the caprolactam was sold to Guanos y Fertilizantes S.A.[39]

Pemex awarded a contract to the M. W. Kellogg Co. of the United States for the design and engineering of a 1,000-ton-per-day ammonia plant. In addition to the engineering, Kellogg was to be responsible for the construction, commissioning, and assistance in procurement of specialized equipment. The ammonia plant was to be built at the petrochemical complex at Cosoleacaque and will be the first large-scale ammonia plant in Mexico designed by Kellogg. Completion of the plant was scheduled for 1974, and the ammonia was to be used domestically.[40]

---

[34] Chemical Marketing Reporter. Fertilizer Industry of Japanese Climbing Out of the Doldrums as Export Mart Comes to Life. V. 202, No. 9, Aug. 28, 1972, pp. 7, 36.

[35] European Chemical News. MITI Urges Retreat From N, Urea Exports. V. 22, No. 559, Nov. 17, 1972, p. 8.

[36] European Chemical News. New Process Coal Gas Distillation Unit On Stream. V. 22, No. 546, Aug. 18, 1972, p. 6.

[37] Chemical Age. Japan To Cut Back Ammonium Sulfate Production. V. 104, No. 2748, Mar. 17, 1972, p. 20.

[38] Chemical Marketing Reporter. Fertilizer Makers Enjoy Brisk Demand in Japan. V. 202, No. 1, July 3, 1972, p. 19.

[39] European Chemical News. Caprolactam Unit Started in Mexico. V. 22, No. 560, Nov. 24, 1972, p. 10.

[40] European Chemical News. Kellogg Builds Pemex NH_3 Unit. V. 22, No. 542, July 21, 1972, p. 10.

Netherlands.—Nederlandse Stikstof Mattschappij NV (NSM), a Belgian corporation, was a major factor in the Dutch chemical industry because all of the corporation's production plants are at Sluiskil near Terneuzen in the Netherlands. The corporation (NSM) was owned by Montecatini Edison, S.p.A. (Montedison) (69%), Imperial Chemical Industries Ltd. (25%), and the French steel group, Wender-Sidelor (6%). NSM started producing nitrogenous fertilizers in 1930 with coke oven gas as the feedstock. The company was the second largest producer of nitrogenous materials in the Netherlands in 1972. Ammonia was produced by NSM in three modern plants which used steam reforming of domestic natural gas to produce the required hydrogen, and capacity was 550,000 tons per year of contained nitrogen. The major part of the ammonia production was used internally for the production of nitrogenous fertilizers and technical nitrogen products. The plants are ideally located for export markets as they are along the Gent-Terneuzen Canal, which is accessible, through locks, to oceangoing vessels up to 60,000 tons. At NSM's own quay, more than 1 million tons per year of nitrogen-containing products were handled.

An unusual project, which was underway in the Netherlands during the year, was soil freezing with liquid nitrogen during the construction of an underground railway system in Amsterdam.[41]

Norway.—Additional production facilities at the Glomfjord Fabrikker fertilizer plant owned by Norsk Hydro A/S were to be completed by yearend. The expansion was to double the plant's capacity to produce calcium nitrate and complex fertilizers.[42]

Norsk Hydro started bulk transportation of calcium nitrate. During the year a ship destined for the United States took on board 6,000 tons of calcium nitrate, 9,000 tons of urea, and 3,000 tons of complex fertilizers at the port of Heroya. A company representative said that this was one of the largest bulk cargoes of fertilizers ever loaded on a single vessel, but that the long distance and the increasing cost of landing bagged cargo in American ports made bulk transportation necessary.[43]

Poland.—The Wloclawek fertilizer plant northwest of Warsaw was formally inaugurated and started to supply the northern Polish market. Plant capacity is 1,500 tons per day of ammonia, 1,800 tons per day of nitric acid, and 2,400 tons per day of ammonium nitrate. Feedstock for the plant is natural gas.[44]

Qatar.—The 330,000-ton-per-year ammonia plant of Qatar Fertilizer Co. entered the initial commissioning stage at Umm Said. Ammonia production was to commence in July and the 360,000-ton-per-year urea plant was to start operation by yearend. The plants were owned by the Qatar Government (63%), Norsk Hydro (10%), Hambros Bank (10%), and Power-Gas (7%). Natural gas feedstock for the plant was to come from Qatar's Western Duckham oilfield. Ammonia and urea from the plant were expected to be exported to Asia, East Africa, and the People's Republic of China.[45]

Rhodesia, Southern.—Sable Chemical Industries was reported to be commissioning its new ammonia plant at Que Que. An Australian producer was believed to have supplied the bulk of Rhodesia's ammonia requirements in the past by shipping material into Lourenço Marques and then by rail into Que Que for the production of ammonium nitrate. Shipments of Australian ammonia were expected to drop off as the Sable plant, believed to have a capacity of between 60,000 and 70,000 tons per year of contained nitrogen, entered into production.[46]

South Africa, Republic of.—A 1,000-ton-per-day ammonia plant was to be built at Midderfontein in South Africa by African Explosives & Chemical Industries, Ltd. The plant will be based on the use of coal feedstock, and a $50 million contract for the plant was awarded to the West German contractors, Heinrich Koppers G.m.b.H. Completion was scheduled for 1974.[47]

---

[41] European Chemical News. Principal Chemical Companies in the Netherlands. V. 22, No. 563, Dec. 15, 1972, pp. 63, 70.

[42] Chemical Age International. Norsk Hydro Fertilizer Expansion for Late Autumn. V. 105, No. 2767, July 28, 1972, p. 15.

[43] Chemical Marketing Reporter. Fertilizers From Norsk Come to the U.S. in Bulk. V. 202, No. 4, July 24, 1972, p. 16.

[44] Chemical Age International. Ensa Built Polish Fertilizer Plant Started Up. V. 105, No. 2770, Aug. 18, 1972, p. 13.

[45] European Chemical News. Qatar Fertilizer Project Nears Start-Up. V. 21, No. 530, Apr. 28, 1972, p. 4.

[46] European Chemical News. Rhodesia Commissions Ammonia Plant. V. 22, No. 541, July 14, 1972, p. 8.

[47] Chemical Marketing Reporter. Ammonia Plant To Use Coal. V. 201, No. 21, June 5, 1972, p. 4.

Spain.—At yearend, Spain had 12 plants with capacity to produce ammonia.[48] Their capacity in thousand tons NH_3 per year was as follows:

Company and location	*Capacity*	*Process*
Eiasa, Huesca	10	Electrolysis.
Sefranitro, Bilbao	90	Coking gas recovery.
Ensidesa, Aviles	107	Do.
Encaso, Puentes	22	Lignite gasification.
Nicas, Valladolid	60	Partial oxidation.
Cinsa, Gran Canaria	35	Do.
Encaso, Puertallano	198	Naphtha reforming.
Repesa, Cartagena	264	Do.
Aesa, Malaga	100	Do.
Inquitasa, Tarragona	20	Do.
Fertiberia, La Coruña	95	Do.
Fertiberia, Huelva	90	Do.
Total	1,091	

Unión Explosivos Rio Tinto awarded contracts for an ammonia and urea complex to be built at Seville, Spain. The ammonia plant was to have a capacity of 300,000 tons per year and will be based upon M. W. Kellogg Co. technology. Kellogg was to supply the engineering responsibilities for the plant, and construction was to be by the Spanish contractor, Tecnicas Reunidas. Startup of the plant was scheduled for 1975. Urea production was to be 165,000 tons per year and Mitsui of Japan was to supply the process. Toyo Engineering of Japan was to handle the engineering, while the Spanish contractor, Heredia y Moreno, was to do the actual construction. During the last two years Spain became a net importer of ammonia, but new production capacity was planned to meet Spain's rising demand.[49]

Nitratos de Castilla was to commission a new 100,000-ton-per-year complex fertilizer plant at Valladolid, Spain. The plant was to produce complex fertilizers containing 12% and 16% nitrogen. The new plant was the first to utilize a new nitrophosphate process based on a combination of the Kampka-Nitro process of the German company, Chemische Fabrik Kalk, and the continuous crystallization process of Severoceske Chemicke Zavady, Czechoslovakia. In the new process, slurry obtained from acidulation of phosphate rock was cooled to facilitate separation of calcium nitrate tetrahydrate by crystallization. The separated calcium nitrate tetrahydrate was converted into ammonium nitrate solution and pure calcium carbonate by a combination of carbonation and ammoniation in specially designed reactors. Ammonium nitrate solution was used for production of ammonium nitrate and calcium ammonium nitrate, or recycled to the fertilizer plant to increase the nitrogen content of the product.[50]

United Kingdom.—The use of a unit-train system by the British Oxygen Corp. (BOC) enabled it to offset the effects of inflation in the United Kingdom and to lower the price of nitrogen. The unit train was the heart of a complex distribution system with the objectives of making liquid elemental nitrogen available where required and making best use of production capacity. The main impetus for development of the system was the increasing congestion on roads in the United Kingdom and the increasing cost of energy.

The unit trains consisted of from 10 to 12 cryogenic tank cars, each with a 50-ton capacity. The trains were able to go anywhere in the system (primarily between Widnes, Sheffield, Wolverhampton, and Wembley) and back within 24 hours. There were 16 sources of nitrogen, storage at 32 points covering 21 demand centers, and a distribution center with 136 major routes.[51]

Fisons Fertilizers Ltd., was building an anhydrous ammonia storage tank at Avonmouth Docks, which was to have a capacity of 15,000 tons with an annual throughput of 120,000 to 150,000 tons.[52]

The United Kingdom cut by 60% the value of the subsidy paid to farmers for the use of fertilizers. Purpose of the cut was said to be a switch to European Economic Community methods and to require the farmer to recover the higher fertilizer cost through higher prices for consumer products. The effect of the subsidy cut was not clear at yearend, and it could simply result in a cut in fertilizer usage below the optimum level.[53]

Air Products Ltd. was to supply six vacuum-insulated nitrogen storage tanks each with a capacity of 54,600 liters. Three of

[48] European Chemical News. Spain Reviews Aromatics and Fertilizer Sectors. V. 22, No. 559, Nov. 17, 1972, p. 6.
[49] European Chemical News. Kellogg and Toyo Win ERT Fertilizer Orders. V. 22, No. 559, Nov. 17, 1972, p. 12.
[50] European Chemical News. Nitratos de Castilla Commissions New Process NPK Plant. V. 21, No. 524, Mar. 17, 1972, p. 8.
[51] European Chemical News. British Oxygen Optimizes Production With Linear Trains. V. 22, No. 562, Dec. 8, 1972, p. 10.
[52] Feed & Farm Supplies. New Anhydrous Ammonia Tanks. V. 69, No. 9, Sept. 1972, p. 26.
[53] Feed & Farm Supplies. Sixty Percent Reduction in One Stroke. V. 69, No. 4, April 1972, p. 18.

these tanks were to be installed at the Hinkley Point B and three at the Hunterston B nuclear powerplants. The system was to provide gaseous nitrogen at 700 pounds per square inch and 250° C for injection, as required, into the reactors' coolant circuits. The gaseous nitrogen was to be obtained by vaporizing the liquid nitrogen withdrawn from storage.[54]

U.S.S.R.—A large fertilizer trade deal with the U.S.S.R. was proposed to Soviet officials by the chairman of Occidental Petroleum Corp. The proposal called for Occidental to supply 1 million tons per year of superphosphoric acid to the U.S.S.R. and to receive in return $150 million worth of urea and ammonia.[55]

Construction work at the Nevinomysk combine was going ahead smoothly, and nitric acid and ammonium nitrate units were being completed a year ahead of the original completion date. Two dilute nitric acid units were onstream, and a third unit was about to undergo trial runs. An ammonium nitrate plant with a capacity of 680,000 tons per year was commissioned during March, and an ammonia plant was expected to be onstream before yearend.[56]

Venezuela.—Venezolana del Nitrógen (Nitroven) was to supply urea fertilizer to the People's Republic of China from its new complex at El Tablazo, Venezuela. Two 900-ton-per-day ammonia plants and two 1,200-ton-per-day urea plants were commissioned at El Tablazo during the year. In addition, a 600-ton-per-day ammonia plant and 750-ton-per-day urea plant were started up at Morón. Two contracts were finalized with China for a supply of urea fertilizers worth $23 million. Nitroven expected to capture a 10% share of the world market for urea.[57]

[54] Chemistry & Industry. Nitrogen for Nuclear Reactor Purging. No. 11, June 3, 1972, p. 432.
[55] Chemical Engineering. Chementator. V. 79, No. 22, Oct. 2, 1972, p. 17.
[56] European Chemical News. USSR Starts AN Plant. V. 21, No. 534, May 26, 1972, p. 8.
[57] European Chemical News. Nitroven Sells Urea to China. V. 22, No. 563, Dec. 15, 1972, 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		
	1969–70	1970–71	1971–72	1969–70	1970–71	1971–72
North America:						
Canada	740	800	[e] 838	298	322	[e] 370
Costa Rica	[e] 14	13	19	[e,1] 44	[1] 41	[1] 53
Cuba	--	5	[e] 11	[1] 197	[1] 175	[e,1] 110
Dominican Republic	--	--	--	[e] 17	17	29
El Salvador [e]	9	9	9	39	50	69
Guatemala	--	--	[e] 3	15	32	[e] 30
Mexico	399	364	361	432	483	572
Netherlands Antilles [e]	39	48	13	--	--	--
Trinidad and Tobago [e,2]	83	110	104	6	6	10
United States (includes Puerto Rico)	8,413	8,996	9,169	7,459	8,134	8,127
South America:						
Argentina	22	38	[e] 44	39	45	[e] 50
Brazil [1]	7	24	75	181	307	305
Chile [1]	[e] 118	[e] 137	[e] 140	[e] 45	[e] 49	55
Colombia [1]	55	[e] 64	76	60	[e] 71	97
Ecuador	3	[e] 2	[e] 3	24	[e] 20	[e] 22
Peru	36	[e] 22	28	75	[e] 73	90
Venezuela	[1] 15	[e] 11	[e] 6	[1] 24	[e,1] 31	[e,1] 36
Europe:						
Albania [e,1]	22	31	33	18	30	32
Austria	273	241	255	133	139	154
Belgium	542	654	676	196	184	184
Bulgaria [1]	596	663	619	426	418	355
Czechoslovakia	[1] 371	[1] 388	[e,1] 404	441	[e] 462	[e] 462
Denmark	78	81	83	298	319	339
Finland	166	213	221	176	187	201
France	1,447	1,489	[e] 1,544	1,368	1,602	[e] 1,651
Germany, East [1]	483	436	428	537	564	636
Germany, West	1,735	1,659	1,456	1,196	1,246	1,247
Greece	161	195	214	210	221	227
Hungary [1]	331	386	416	383	431	434
Iceland [1]	9	8	8	13	13	15
Ireland	[e] 66	[e] 87	[e] 97	79	96	108
Italy	1,059	1,054	1,140	607	655	689
Luxembourg	[e] 2	[e] 2	[e] 2	11	12	13
Netherlands	984	1,025	1,107	427	447	412

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		
	1969–70	1970–71	1971–72	1969–70	1970–71	1971–72
Europe—Continued						
Norway	409	408	423	85	86	90
Poland	[1] 1,034	[1] 1,135	[1] 1,191	865	907	1,000
Portugal	131	105	[e] 149	124	84	[e] 127
Romania [1]	544	713	911	386	404	475
Spain	607	653	742	653	637	735
Sweden [3]	159	180	195	226	249	260
Switzerland	32	28	27	38	40	42
U.S.S.R. [1]	4,970	5,978	6,674	4,187	5,076	5,712
United Kingdom [3]	783	824	852	[4] 761	[4] 883	[4] 1,025
Yugoslavia [1]	202	294	280	313	324	367
Africa:						
Algeria [e]	17	25	43	33	32	87
Egypt, Arab Republic of	[1] 130	[1] 130	[e 1] 132	[5] 342	[5] 365	[e 5] 386
Ivory Coast	--	[e] 2	[e] 2	[1] 5	[e 1] 9	[e 1] 6
Kenya [e]	--	--	--	18	24	22
Morocco [1]	5	[e] 14	[e] 19	38	[e] 41	[e] 49
Mozambique	--	1	2	5	5	7
Rhodesia, Southern [e]	25	40	42	47	54	53
Senegal	2	5	8	[e] 3	4	6
South Africa, Republic of [e 1]	225	220	259	165	199	230
Sudan	--	--	--	43	[e] 49	[e] 53
Tunisia	[1] 1	[e 1] 1	[e 1] 1	15	[e] 14	[e] 20
Zambia	--	7	10	10	22	36
Asia:						
Bangladesh (formerly E. Pakistan) [e]	50	28	28	118	44	46
Burma	--	17	17	[e] 30	18	24
China, People's Republic of [e 1]	1,146	[6] 1,356	[7] 1,819	2,754	[6] 3,293	[6] 3,494
India	805	[e] 933	1,078	1,499	1,639	1,941
Indonesia	[e] 43	50	53	[e] 116	[e] 222	216
Iran	[e] 29	[e] 34	[e] 83	[e] 61	72	118
Iraq	--	[e] 7	12	11	[e] 13	15
Israel	33	30	36	33	35	36
Japan	2,349	2,320	2,338	[8] 983	[8] 962	[8] 965
Korea, North [e 1]	173	226	243	168	226	243
Korea, Republic of [1]	392	425	[e] 496	353	392	[e] 383
Kuwait	81	94	[e] 96	--	--	--
Lebanon [e]	14	15	--	[1] 18	[1] 21	28
Malaysia, West [e]	34	29	47	60	67	79
Pakistan [e 9]	141	168	187	276	344	249
Philippines	59	53	[e] 60	112	131	[e] 134
Saudi Arabia [e]	--	25	47	1	1	2
Sri Lanka (Ceylon)	--	--	--	[e] 54	[e] 64	49
Syrian Arab Republic	--	--	--	22	29	[e] 33
Taiwan	215	[7] 216	[7] 209	182	170	[7] 194
Thailand	[e 1] 9	[e 1] 11	[1] 12	[e] 54	[e] 47	42
Turkey [1]	58	[e] 90	[e] 81	255	[e] 268	[e] 309
Vietnam, North [e 1]	--	--	--	40	42	34
Vietnam, South [e 1]	--	--	--	109	77	108
Oceania:						
Australia [e]	176	160	187	190	159	138
Other:						
North America and Central America [e 10]	--	--	--	74	75	74
South America [e 11]	--	--	--	23	27	35
Europe [12]	--	--	--	2	2	2
Africa [e 13]	--	--	--	91	112	127
Asia [e 14]	--	--	--	40	43	40
Oceania [15]	--	--	--	16	14	18
World total	33,361	36,305	38,693	31,581	34,999	37,148

[e] Estimate.

[1] Calendar year referring to the first part of the split year.

[2] Series revised to conform with data presented by the United Nations in principal source for this table. Excludes nitrogen content of anhydrous ammonia produced for export in that form for subsequent processing elsewhere to other compounds.

[3] Fertilizer year: June–May.

[4] Deliveries by manufacturers or importers to first buyers.

[5] Fertilizer year: November–October.

[6] United States' Bureau of Mines estimate based on United Nations' estimate for People's Republic of China plus Taiwan (not distributed) and British Sulphur Corp. Ltd. reported figure for Taiwan alone.

[7] Source: British Sulphur Corp. Ltd. Statistical Supplement No. 6, November–December 1972, London 1973, pp. 10–11.

[8] Includes data for Ryukyu Islands.

[9] Excluding data for Bangladesh shown separately above.

[10] Includes Barbados, British Honduras, Guadeloupe, Haiti, Honduras, Jamaica, Martinique, Nicaragua, Panama, St. Kitts, Nevis and Anguilla, St. Lucia, and St. Vincent.

[11] Includes Bolivia, Guyana, Paraguay, Surinam, and Uruguay.

[12] Includes Channel Islands (Jersey only) and Isle of Man.

[13] Includes Angola, Botswana, Cameroon, Central African Republic, Chad, Congo (Brazzaville), Dahomey, Equatorial Guinea, Ethiopia, Ghana, Guinea, Liberia, Libya, Malagasy Republic, Malawi, Mali, Mauritius, Mozambique, Nigeria, Reunion, Sierra Leone, Somalia, Swaziland, Tanzania, Togo, Uganda, Upper Volta, and Zaire.

[14] Includes Afghanistan, Burundi, Cyprus, Jordan, Khmer Republic, Laos, Mongolia, Nepal, Ryukyu Islands, and Singapore.

[15] Includes Fiji Islands and New Zealand.

Source: Statistical Office of the United Nations, Statistical Yearbook, 1972. New York, 1973, pp. 280–281, 545–547, unless otherwise specified.

TECHNOLOGY

A new processing method increased the polyphosphate content of nitrogen-phosphate fertilizers and increased the length of time that these materials could be stored. The method was developed and commercialized by the Tennessee Valley Authority. The new method consisted of mixing ammonia and superphosphoric acid, in nearly anhydrous conditions and at high temperature, in a pipe reactor. The initial exothermic reaction took place in the pipe at about 650° F and was complete in seconds. About 60% to 65% of the required ammonia was fed into the pipe reactor, and the remaining ammonia requirement was added in the storage tank. The final product was a liquid fertilizer which contained about 10% nitrogen and 34% P_2O_5 equivalent.

One user of the new process reported that the storage life of this type of fertilizer was increased from 2 weeks to 6 months. The increased storage life was due to the high polyphosphate content produced in the new method, as the polyphosphates sequestered impurities that formerly caused sludge precipitation.

An added advantage of the pipe-reactor process was that it accepted, as feedstock, a superphosphoric acid of lower initial polyphosphate content than other methods yet ended up with a higher grade product. Another advantage was that newly designed portable units could be located on farms or in farming areas. In these cases, ammonia and superphosphoric acid were to be fed directly from tank cars and thus eliminated the need for costly corrosion-resistant storage facilities.[58]

In most industrial caprolactam processes, each ton of caprolactam product was accompanied by 2 to 5 tons of byproduct ammonium sulfate. A new process was developed by Dutch State Mines (DSM) for making cyclohexanone oxime, a key precursor for caprolactam. The DSM process eliminated the production of ammonium sulfate with the oxime and thereby cut the byproduct ammonium sulfate from the overall process by 60%.

In classical caprolactam chemistry, a sequence of reactions yield hydroxylammonium sulfate which reacts with cyclohexanone under neutralization with ammonia to form cyclohexanone oxime and about 2.7 times as much ammonium sulfate as oxime. Subsequent processing of the oxime yields additional ammonium sulfate. The DSM process eliminates a large percentage of the ammonium sulfate by producing hydroxylamine and cyclohexanone oxime in a phosphoric acid buffered reaction. The hydroxylamine solution from the reaction contacts countercurrently with cyclohexanone in the presence of toluene, which acts as a solvent for the oxime produced. Hydrogen ions liberated by the reaction are accepted by the buffer system, and neutralization with ammonia, as in conventional oxime synthesis, is not necessary.

The new process was commercialized with the completion of three plants. One of the plants was in Japan, one in Britain, and one in the United States. Combined capacity of the three plants was 210,000 tons per year of caprolactam.[59]

Azote et Produits Chimiques S.A. of France developed a direct route to pure monoammonium phosphate, from which ammonium polyphosphate and diammonium phosphate could be prepared for agricultural or industrial use. In the process, phosphate rock was treated with nitric acid, and the resulting solution was passed to an extractor. In the extractor, isobutyl alcohol separated out the phosphates. After purification to remove calcium salts, the solution was neutralized with ammonia. The heavy phase from the resulting mixture was cooled and filtered to yield pure ammonium phosphate. The secondary stream contained calcium and ammonium nitrate. Upon recovery of the isobutyl alcohol, the calcium was removed as the carbonate and the ammonium nitrate solution was sent to a fertilizer prilling tower.[60]

A range of new thermoplastic materials, based on nitrile resins, was developed by Imperial Chemical Industries, Ltd., of England for the production of bottles for soft drinks and wine as well as for film and foil for packaging oxygen-sensitive food products. Bottles made from these nitrogen-containing resins were said to be

[58] Chemical Engineering. Pipe Reactor Improves N–P Fluid-Fertilizers. V. 79, No. 18, Aug. 21, 1972, p. 60.

[59] Damme, J., J. T. Van Goolen, and A. H. De Rooij. Cyclohexanone Oxime Made Without Byproduct $(NH_4)_2SO_4$. Chem. Eng., v. 79, No. 15, July 10, 1972, pp. 54–56.

[60] Browning, Jon E. French Processes Paraded. Chem. Eng., v. 79, No. 22, Oct. 2, 1972, p. 34.

tough and rigid and have low permeability to gases such as oxygen and carbon dioxide so that carbonated drinks contained in them had a long shelf life. The potential market for these materials is, of course, large.[61]

A coal gasification process, marketed by Koppers Co., was said to have the potential to relieve the developing shortage of natural gas. The Koppers-Totzek process used commercially proven technology to produce a gas rich in carbon monoxide and hydrogen that could be converted into fuel and process gases or synthetic natural gas of pipeline quality. The process was in operation in 16 plants around the world, primarily to gasify coal of all kinds to produce synthesis gas for ammonia production.[62]

The prilling process for manufacturing solid ammonium nitrate and urea gained worldwide acceptance since its introduction over 30 years ago. In the prilling process, a concentrated solution of ammonium nitrate or urea was sprayed from the top of a tall tower into a rising stream of air which cooled the droplets, which then solidify into spherical pellets.

There are two problems inherent in the prilling process. The first is that the large volume of cooling air used to solidify and cool the prills requires the installation of dust scrubbing equipment on the prilling tower to remove entrained dust. The second is the regulation of product size. The maximum prill size that can be obtained is limited by the economics of the tower height, 70 to 170 feet, required to provide sufficient free fall for solidification and cooling of the liquid spray. The size limitation is more serious with urea because of its lower melting point, 271° F, compared with 337° F for ammonium nitrate. Also, urea has a higher heat of crystallization, 104 Btu's per pound, than ammonium nitrate, 61 Btu's per pound.

Typical ammonium nitrate prills are 95% plus 16 mesh on a Tyler screen and about 65% plus 10 mesh. Urea prills are 95% plus 16 mesh and about 30% plus 10 mesh. These sizes and size distributions were said to be less suitable for bulk blending than product sizes obtained by granulation.

A number of studies have shown that segregation occurred when products having different size ranges were blended or handled. The greatest single factor in producing segregation was size distribution, while differences in shape or density had little effect. Granulated ammonium nitrate or urea, as contrasted with prills, is not limited to a particular size range that can be produced, and the size of granule produced can be regulated as desired by choice of suitable screen sizes.

Originally developed for the production of granular complex fertilizers, a C&I/Girdler, Inc., granulation process utilized the principle of accretion, or layering, to build up onionskin-like layers of ammonium nitrate or urea on small seed particles. This was accomplished by spraying a slurry or solution onto a rolling bed of solid particles in a rotating drum.

The C&I/Girdler, Inc., process differs from that used in most granulation processes. Other granulation processes depend on the agglomeration, or sticking together, of small particles by using a solution or slurry as the binding agent. The agglomeration method was found to be unsuccessful for the granulation of ammonium nitrate.[63]

---

[61] Chemical Marketing Reporter. Nitrile Resins of ICI Groomed for Containers. V. 202, No. 24, Dec. 11, 1972, p. 27.

[62] Farm Chemicals & Croplife. Answer to Natural Gas Shortage? V. 135, No. 8, Aug. 1972, p. 35.

[63] Reed, R. M., and J. C. Reynolds. The Spherodizer Granulation Process. Chem. Eng. Prog., v. 69, No. 2, February 1973, pp. 62–66.

Peat

By Eugene T. Sheridan [1]

Peat production in the United States decreased 5% in 1972, principally because a smaller number of plants were operating than in 1971. Production declined in 14 States, and active plants decreased by 17. The largest production losses were recorded in Florida, Indiana, Minnesota, and Pennsylvania.

Commercial sales, which were 5% greater than production because about 30,000 tons of peat was sold from stockpiles, were 1% greater than in 1971. The total value of sales also increased slightly because of the larger quantity sold and because of an increase of $0.03 per ton in the average value of all peat sold.

Imports increased 5%, and the quantity of peat imported in 1972 was about one-half the quantity produced domestically. Ninety-six percent of the peat imported was shipped from Canada.

World production was estimated at 89 million short tons. The U.S.S.R. was the largest producer with an output estimated at 80 million tons, 89% of the world total.

[1] Mineral specialist, Division of Fossil Fuels

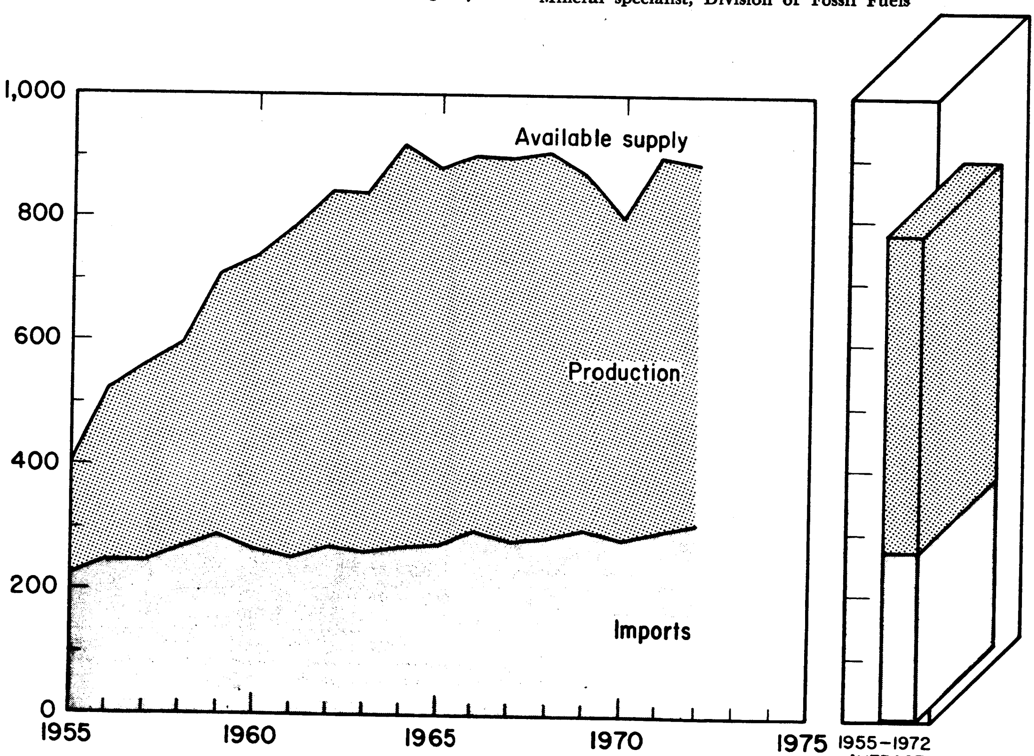

Figure 1.—Production, imports, and available supply of peat in the United States.

DOMESTIC PRODUCTION

The 5% decrease in production in 1972 resulted principally from a smaller output of moss peat and humus. This loss was partially offset by a 5% increase in reed-sedge production.

Twenty-two States produced peat in 1972 compared with 24 States in 1971. Michigan remained the largest producer with 36% of the Nation's output. Illinois, Florida, New Jersey, Colorado, California, and Indiana followed in output in the order named. These States, with Michigan, provided nearly four-fifths of the total production.

Table 1.—Salient peat statistics

	1969	1970	1971	1972
United States:				
Number of operations	128	122	120	103
Production short tons	572,122	516,825	605,382	576,712
Commercial sales do	565,760	525,603	599,548	606,679
Value of sales thousands	$7,055	$5,986	$7,011	$7,112
Average per ton	$12.47	$11.39	$11.69	$11.72
Imports short tons	299,997	283,211	296,283	310,491
Available for consumption [1] do	865,757	808,814	895,831	917,169
World: Production thousand short tons	r 89,431	92,026	89,610	89,338

r Revised.
[1] Commercial sales plus imports.

Table 2.—Peat produced in the United States in 1972, by kind
(Short tons)

Kind	Unprepared	Processed: Shredded	Processed: Kiln-dried only	Processed: Shredded and kiln-dried	Total
Moss	56,539	79,191	1,075	2,468	139,273
Reed-sedge	105,235	219,345	--	--	324,580
Humus	15,123	95,561	1,775	400	112,859
Total	176,897	394,097	2,850	2,868	576,712

Table 3.—Production and commercial sales of peat in the United States in 1972, by State

State	Active plants	Production (short tons)	Commercial sales: Short tons	Value: Total (thousands)	Value: Average per ton
California	3	29,233	29,233	$620	$21.20
Colorado	10	38,528	38,528	210	5.44
Florida	8	45,424	45,424	362	7.97
Georgia	2	W	W	W	W
Illinois	5	69,523	74,003	935	12.64
Indiana	9	24,413	45,321	478	10.54
Iowa	2	W	W	W	W
Maine	4	3,013	2,083	99	47.60
Maryland	1	2,653	2,653	29	11.03
Massachusetts	1	W	W	W	W
Michigan	19	208,691	219,251	2,190	9.99
Minnesota	3	W	W	W	W
Montana	1	750	750	W	W
New Jersey	4	W	W	W	W
New Mexico	1	2,436	2,436	46	18.96
New York	5	14,984	14,507	200	13.81
Ohio	7	3,902	3,902	67	17.10
Pennsylvania	9	23,136	22,416	320	14.30
South Carolina	1	14,500	11,200	W	W
Vermont	1	95	95	1	14.74
Washington	6	18,035	18,035	89	4.93
Wisconsin	1	1,815	1,815	179	98.80
Total	103	576,712	606,679	7,112	11.72

W Withheld to avoid disclosing individual company confidential data; included in total.

Table 4.—Relative size of peat operations in the United States

Size	1971				1972			
	Active plants		Production		Active plants		Production	
	Number	% of total	Short tons	% of total	Number	% of total	Short tons	% of total
Under 500 tons	29	24.1	5,868	1.0	26	25.2	6,142	1.0
500 to 999 tons	17	14.2	11,649	1.9	11	10.7	7,678	1.3
1,000 to 4,999 tons	44	36.7	93,949	15.5	38	36.9	86,279	15.0
5,000 to 14,999 tons	20	16.7	182,622	30.2	18	17.5	170,153	29.5
15,000 to 24,999 tons	4	3.3	67,388	11.1	6	5.8	111,240	19.3
Over 25,000 tons	6	5.0	243,906	40.3	4	3.9	195,220	33.9
Total	120	100.0	605,382	100.0	103	100.0	576,712	100.0

Active operations decreased from 120 to 103, but average output per plant increased 11% to 5,599 tons. Three-fourths of the operations, however, had outputs smaller than the average. Only 28 plants had production in excess of 5,000 tons, and only four plants produced more than 25,000 tons.

Roughly one-third of the peat was sold as produced with no processing other than air drying. Most of the remainder was shredded, and a small quantity was subjected to thermal drying.

CONSUMPTION AND USES

Commercial sales and imports both increased in 1972, and the amount of peat available for consumption was about 2% greater than in 1971.

Peat was used for a variety of purposes, but 85% of the total commercial sales reported by producers was 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 lawns and golf course greens and for transplanting trees and shrubs; and garden, hardware, and variety stores, which sold peat to homeowners for mulching and for improving lawn and garden soils. Most of the remaining peat was sold for use in potting soils and for packing flowers and shrubs, but small quantities were used in mushroom beds and in mixed fertilizers and for earthworm culture and seed inoculant.

Fifty-four percent of the tonnage of peat sold commercially by producers was packaged. Packaged peat, however, accounted for more than two-thirds of the total value of sales. Of the total peat sold in packages,

Table 5.—Commercial sales of peat in the United States in 1972, by kind and use [1]

Use	Moss		Reed-sedge		Humus	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
Bulk:						
Soil improvement	56,882	$545	75,764	$688	65,400	$433
Other uses	23,058	121	37,096	346	18,335	130
Total	79,940	665	112,860	1,035	83,735	563
Packaged:						
Soil improvement	84,467	1,613	212,765	2,375	23,305	508
Other uses	2,423	66	4,821	69	2,363	217
Total	86,890	1,678	217,586	2,444	25,668	725
Total:						
Soil improvement	141,349	2,158	288,528	3,063	88,705	941
Other uses	25,481	187	41,917	415	20,698	347
Grand total	166,830	2,344	330,446	3,479	109,403	1,289

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

Table 6.—Commercial sales of peat in the United States in 1972, by use

Use	In bulk		In packages		Total [1]	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
Soil improvement	198,046	$1,666	320,537	$4,495	518,583	$6,161
Potting soils	27,032	222	6,762	117	33,794	339
Packing flowers, shrubs, etc	27,304	221	170	8	27,474	229
Seed inoculant	--	--	2,448	224	2,448	224
Mushroom beds	2,749	38	--	--	2,749	38
Earthworm culture	5,767	50	227	4	5,994	54
Mixed fertilizers	15,637	66	--	--	15,637	66
Total [1]	276,535	2,264	330,144	4,848	606,679	7,112

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

about two-thirds was reed-sedge peat, about one-fourth was moss peat, and the remainder was peat humus.

States leading in sales of packaged peat were Michigan, Illinois, Indiana, and New Jersey, which, together, reported 84% of the total sales of packaged peat. Michigan was the largest producer of packaged peat with 55% of the total sales.

PRICES AND SPECIFICATIONS

Prices of peat at individual operations varied greatly in 1972, with the price depending mainly upon the kind of peat sold, the amount of processing, and whether the material was sold packaged or in bulk.

The overall average value per ton, f.o.b. plant, for peat sold in 1972 was $11.72. This was an increase of $0.03 per ton over the average value of 1971, and the bulk of the increase was attributed mainly to higher average receipts for peat sold by producers in New Jersey, Ohio, and Pennsylvania.

The average price of bulk peat increased $0.31 per ton to $8.19. Packaged prices, however, decreased an average of $0.20 per ton to $14.68. The average price for bulk peat was influenced mainly by higher overall prices for bulk sales by California, Pennsylvania, and South Carolina producers; the decline in the unit value of packaged peat was attributed to generally smaller receipts for each ton of packaged peat sold by Michigan producers.

Imported peat had a total value of $17.2 million. The total value of imported peat was 13% greater than in 1971, partially because there was 14,000 tons more peat imported but also because the average value per ton increased from $51.11 to $55.31.

Although the average value of imported peat was nearly four times that of domestically produced packaged peat, their values are not comparable because they are assigned at different marketing levels. Also, imported peat has different physical properties than most of the peat sold domestically, and it is usually 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 quantity of a typical domestic peat will measure 3 to 4 bushels. Only a few domestic operations produced peat with properties similar to those of the imported kind.

Peat is broadly classified in the United States as moss peat, reed-sedge peat, and humus, according to the materials from which it has been formed and its degree of decomposition. Moss peat is a type that has been formed principally from sphagnum, and/or other mosses; reed-sedge peat has originated mainly from reeds, sedges, and other swamp plants; and humus is peat too decomposed for identification of its biological origin.

FOREIGN TRADE

The quantity of peat imported into the United States in 1972 totaled 310,000 short tons. This was 5% more peat than was imported in 1971 and the largest quantity imported in any year to date.

Canada provided the bulk of the imports, supplying 96% of the total peat imported. Virtually all of the remaining foreign peat was supplied by Europe.

European shipments decreased 8%, principally because of smaller shipments from West Germany, Ireland, and Sweden. The decline in shipments from these countries, however, was partially offset by a substantially larger shipment from Poland.

Imported peat was classified according to

Table 7.—U.S. imports for consumption of peat moss, by grade and country

Country	Poultry and stable grade		Fertilizer grade		Total	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1971						
Canada	1,941	$129	281,519	$14,403	283,460	$14,532
Denmark	--	--	19	1	19	1
Germany, West	513	21	9,327	423	9,840	444
Ireland	6	3	172	10	178	13
Mexico	--	--	93	4	93	4
Netherlands	13	1	--	--	13	1
Poland	--	--	2,308	121	2,308	121
Sweden	--	--	319	22	319	22
United Kingdom	--	--	53	4	53	4
Total	2,473	154	293,810	14,988	296,283	15,142
1972						
Canada	2,057	162	296,743	16,335	298,800	16,497
France	--	--	14	1	14	1
Germany, West	857	46	7,337	450	8,194	496
Ireland	--	--	14	1	14	1
Norway	22	2	--	--	22	2
Poland	187	6	3,075	163	3,262	169
Sweden	3	3	--	--	3	3
Taiwan	22	1	--	--	22	1
U.S.S.R.	110	2	--	--	110	2
United Kingdom	--	--	50	1	50	1
Total	3,258	222	307,233	16,951	310,491	17,173

Table 8.—U.S. imports for consumption of peat moss in 1972, by grade and customs district

Customs District	Poultry and stable grade		Fertilizer grade		Total	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
Baltimore, Md	61	$4	994	$45	1,055	$49
Boston, Mass	--	--	234	18	234	18
Buffalo, N.Y	135	11	22,982	1,236	23,117	1,247
Charleston, S.C	17	1	--	--	17	1
Detroit, Mich	142	11	44,977	2,880	45,119	2,891
Duluth, Minn	--	--	3,230	284	3,230	284
Great Falls, Mont	22	1	8,557	491	8,579	492
Honolulu, Hawaii	6	1	--	--	6	1
Houston, Tex	--	--	408	22	408	22
Los Angeles, Calif	--	--	659	42	659	42
Miami, Fla	--	--	233	19	233	19
Mobile, Ala	428	23	1,346	76	1,774	99
New Orleans, La	--	--	1,533	65	1,533	65
New York, N.Y	136	6	962	58	1,098	64
Norfolk, Va	--	--	448	19	448	19
Ogdensburg, N.Y	19	1	85,068	4,235	85,087	4,236
Pembina, N. Dak	1,174	80	21,059	1,113	22,233	1,193
Philadelphia, Pa	109	5	528	32	637	37
Portland, Maine	542	56	12,999	658	13,541	714
Portland, Oreg	32	2	102	5	134	7
St. Albans, Vt	17	1	45,273	2,236	45,290	2,237
San Francisco, Calif	69	6	636	71	705	77
San Juan, P.R	--	--	769	53	769	53
Savannah, Ga	182	7	339	16	521	23
Seattle, Wash	--	--	52,605	3,200	52,605	3,200
Tampa, Fla	167	6	1,292	77	1,459	83
Total	3,258	222	307,233	16,951	310,491	17,173

use as poultry-and-stable-grade peat and fertilizer-grade peat. Of the total imported, 99% was duty-free fertilizer-grade peat. A duty of $0.25 per long ton was levied on poultry-and-stable-grade peat.

Foreign peat entered the United States through 26 customs districts in 1972, but 88% of the total was shipped through the Buffalo and Ogdensburg, N.Y.; Detroit, Mich.; Pembina, N. Dak.; St. Albans, Vt.; and Seattle, Wash., customs districts. The largest quantity, 85,000 tons, was shipped through the Ogdensburg district.

Table 9.—Peat moss imported for consumption from Canada and West Germany in 1972, by grade and customs district

Customs district	Canada				West Germany			
	Poultry and stable grade		Fertilizer grade		Poultry and stable grade		Fertilizer grade	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
Baltimore Md	--	--	--	--	17	$1	994	$45
Boston, Mass	--	--	57	$3	--	--	--	--
Buffalo, N.Y	135	$11	22,982	1,237	--	--	--	--
Charleston, S.C	--	--	--	--	17	1	--	--
Detroit, Mich	142	11	44,977	2,880	--	--	--	--
Duluth, Minn	--	--	3,230	284	--	--	--	--
Great Falls, Mont	22	1	8,557	491	--	--	--	--
Honolulu, Hawaii	6	1	--	--	--	--	--	--
Houston, Tex	--	--	--	--	--	--	203	11
Los Angeles, Calif	--	--	--	--	--	--	659	42
Miami, Fla	--	--	--	--	--	--	141	9
Mobile, Ala	--	--	--	--	428	23	1,346	76
New Orleans, La	--	--	--	--	--	--	144	6
New York, N.Y	--	--	--	--	--	--	720	45
Norfolk, Va	--	--	--	--	--	--	298	13
Ogdensburg, N.Y	19	1	85,054	4,234	--	--	--	--
Pembina, N. Dak	1,174	80	21,059	1,113	--	--	--	--
Philadelphia, Pa	--	--	--	--	109	5	378	22
Portland, Maine	542	56	12,999	658	--	--	--	--
Portland, Oreg	--	--	--	--	32	2	102	5
St. Albans, Vt	17	1	45,273	2,236	--	--	--	--
San Francisco, Calif	--	--	--	--	69	6	636	71
San Juan, P.R	--	--	--	--	--	--	769	53
Savannah, Ga	--	--	--	--	130	6	205	12
Seattle, Wash	--	--	52,555	3,199	--	--	--	--
Tampa, Fla	--	--	--	--	55	2	742	40
Total	2,057	162	296,743	16,335	857	46	7,337	450

WORLD REVIEW

World production of peat in 1972 was estimated at 89 million short tons. While this appears to be less than one-half the quantity previously estimated for 1971 world output, it in actuality reflects a revision in the data previously reported for the U.S.S.R. Output statistics for the U.S.S.R. in 1972 and previous years were adjusted downward to reflect reported data based upon study tour reports and fully documented official production figures. The data now exclude peat produced by collective farms in the U.S.S.R., which had previously been estimated but for which no reliable data could be obtained.

Despite the exclusion of a portion of the total Soviet output, the U.S.S.R. was by far the largest peat producer with an estimated 89% of the world production. According to published Soviet figures, 30 million tons of peat was produced by State enterprises for agricultural use, and about 50 million tons was produced 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 domestic and industrial heating.

Ireland ranked second in peat production with an estimated output of 5.8 million short tons. Virtually all of Ireland's production was fuel peat that was used for electric-power generating and household heating. A small amount of agricultural peat was produced, principally for export.

West Germany, the third-ranking peat

producer with 1.8 million short tons, provided about 2% of the world output. Most of the West German production was agricultural peat, but about one-fifth was consumed as fuel.

Other producers ranking in output in the order named were the United States, the Netherlands, Canada, and Finland. The combined output of these countries was, however, only 2% of the total. Although fourth in world production, output of the United States was only 0.7% of the world total.

Table 10.—Peat: World production, by country

(Thousand short tons)

Country [1]	1970	1971	1972 p
Argentina, agricultural use	3	e 3	e 3
Canada, agricultural use	r 321	326	370
Denmark, fuel e	6	6	6
Finland:			
Agricultural use	159	259	140
Fuel	97	112	166
France, agricultural use	85	e 90	e 90
Germany, West:			
Agricultural use	r 1,306	1,494	e 1,440
Fuel	357	352	313
Hungary, agricultural use e	72	72	72
Ireland:			
Agricultural use	58	63	e 70
Fuel	r 5,908	6,058	e 5,700
Israel, agricultural use e	22	22	22
Japan e	80	80	80
Korea, Republic of, agricultural use	9	4	e 4
Netherlands e	440	440	440
Norway:			
Agricultural use	12	e 12	e 12
Fuel e	6	e 6	e 6
Poland, fuel	55	e 55	e 55
Spain	18	e 19	e 19
Sweden:			
Agricultural use	r 113	127	e 130
Fuel e	23	23	23
U.S.S.R.:			
Agricultural use e	r 30,000	30,000	30,000
Fuel	52,359	49,382	e 49,600
United States, agricultural use	517	605	577
Total	r 92,026	89,610	89,338
Fuel peat included in total	r 58,811	55,994	55,869

e Estimate. p Preliminary. r Revised.
[1] In addition to the countries listed, Austria Canada, Iceland, and Italy produce a negligible quantity of fuel peat. No data are available for East Germany, a major producer.

TECHNOLOGY

Experimental work conducted at the University of Sherbrooke, Quebec, Canada,[2] indicated that mercury present in waste water can be removed and recovered quantitatively by treatment with peat. The humic acids contained in peat are known to be good ion-exchange resins, and the studies have shown that contaminated waters can be made virtually mercury-free if treated with moss peat in the presence of a precipitating agent such as sodium sulfide. Recovery of mercury is accomplished by burning the peat containing mercury in the presence of a limited amount of air. Vapors of mercury and sulfur dioxide are eliminated in a scrubbing tower containing limestone and elemental sulfur, and metallic mercury can be decanted from the water.

Field and laboratory studies conducted at the University of Minnesota[3] have shown that peat soil and various mixtures of sand, calcitic limestone, and peat can be used as filter media to remove significant amounts of phosphorus and organic materials from wastewaters. The treatment

[2] Lalancette, J. M., and B. Coupal. Recovery of Mercury From Polluted Water Through Peat Treatment. Proc. 4th Internat. Peat Cong., Otaniemi, Finland, June 25–30, 1972, v. 4, pp. 213–217.

[3] Farnham, R. S., and J. L. Brown. Advanced Wastewater Treatment Using Organic and Inorganic Materials. Proc. 4th Internat. Peat Cong., Otaniemi, Finland, June 25–30, 1972, v. 4, pp. 271–298.

processes used in the experiments were physical and chemical as well as biological in nature, and the major emphasis was placed upon the removal of phosphorus, which has become a major pollutant in recent years. The studies also showed that various types of peat can be used in such filter systems and that the systems are not only efficient, but they can be operated at relatively high application rates.

Additional research work on peat at the University of Sherbrooke,[4] evaluated the use of peat as an absorbing agent for the removal of coloring matter from the effluent of a dye house at a textile plant. Many of the dyes used by the textile industry are nonbiodegradable, and their removal in an economic manner remains a problem. Adsorption of these dyes with activated carbon is one of the most promising of the processes proposed or used, but activated carbon is a relatively expensive material for this use. The study concluded that sphagnum peat moss of the blond type has good absorption capacity for basic dyes, but this capacity decreases for dyes that are acidic. Also, with an actual effluent from a dye house, competitive adsorption with other polluting material decreased the efficiency of peat moss in reducing the concentration of dyestuff.

Laboratory tests,[5] confirmed partly on a pilot and technical scale, in Raciborz, Poland, show that peat can be used effectively as a basic raw material to obtain a number of activated carbons with good physical, chemical, and adsorption properties. Such carbons may be produced, both by gas activation in which peat is treated with steam, carbon dioxide, or air at 700° to 1,000°C, or by chemical activation, based upon the impregnation of peat with chemical compounds. The chemical activation method uses chemicals such as zinc chloride or phosphoric acid to impregnate the peat, after which it is carbonized and activated at 600° to 700°C. Activated carbons with a high proportion of micropores are generally used for gas and vapor adsorption, carbons with medium-sized pores are used for catalytic and special applications, and macroporous carbons serve as decolorizing and medicinal agents. Peat has been used for the production of all of the aforementioned types of activated carbon as a replacement raw material for wood charcoal, which is more costly and, in Poland, becoming increasingly less available because of a timber deficit. Baltic-type peat from the Szczencin and Lebork regions of Poland, which is characteristically low in ash content, is especially amenable to activated carbon production.

---

[4] Dufort, Jean, and Maurice Ruel. Peat Moss As An Adsorbing Agent for the Removal of Coloring Matter. Proc. 4th Internat. Peat Cong., Otaniemi, Finland, June 25–30, 1972, v. 4, pp. 299–310.

[5] Fica, Jozef. Investigations on Peat Utilization for the Production of Activated Carbon. Proc. 4th Internat. Peat Cong., Otaniemi, Finland, June 25–30, 1972, v. 4, pp. 185–196.

Perlite

By Arthur C. Meisinger [1]

Record totals were established in 1972 for production and consumption of crude and expanded perlite in the United States and effectively reversed the overall decline that had hit the domestic perlite industry in 1971. Compared with 1971 production, the quantity of crude perlite mined increased 31% and the quantity and value of crude perlite sold or used each increased 26%. Although there were three fewer expanding plants in operation during 1972, the quantities of expanded perlite produced and sold or used exceeded those of 1971 by 10% and 9%, respectively. The value of expanded perlite sold or used also reached a record total of $25.35 million for an increase of 9% over that of 1971. New Mexico and Illinois continued to be the leading States in production of crude and expanded perlite, respectively.

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						Expanded perlite		
	Quantity mined	Sold		Used at own plant to make expanded material		Total quantity sold and used	Quantity produced	Sold or used	
		Quantity	Value	Quantity	Value			Quantity	Value
1968	558	202	1,975	226	2,246	428	339	336	15,265
1969	613	205	2,087	266	3,013	471	405	402	22,100
1970	607	176	2,056	280	2,848	456	420	416	24,972
1971	495	175	2,062	257	2,879	432	389	385	23,156
1972	649	224	2,540	321	3,691	545	427	421	25,350

DOMESTIC PRODUCTION

Crude perlite was produced by 12 companies at 13 mines in seven States in 1972 compared with 11 companies and 12 mines in six States in 1971. The quantity of crude perlite mined was a record 649,000 tons surpassing by 11,000 tons the previous high of 638,000 tons mined in 1967. New Mexico, with 87% of the U.S. crude perlite mined, continued to be the principal producing State. Other producing States, in descending order, were Arizona, California, Nevada, Colorado, Idaho, and Texas.

Crude perlite sold or used to make expanded materials set record totals in quantity and value in 1972. Producers sold or used 545,000 tons of crude perlite valued at $6,231,000 compared with the previous high of 471,000 tons and $5,100,000 in 1969.

Crude perlite was expanded at 84 plants in 30 States in 1972, and record quantities were established for expanded perlite produced and sold or used. The quantity of expanded perlite produced was 427,000 tons compared with the previous high of 420,000 in 1970. The quantity of expanded perlite sold or used in 1972 was 421,000 tons and exceeded the previous high of 416,000 in 1970 by 5,000 tons. The value of expanded perlite sold or used was $25.35 million compared with the previous record total of $24.97 million in 1970. Illinois continued to be the leader in production

[1] Industry economist, Division of Nonmetallic Minerals.

of expanded perlite and in the quantity sold or used. Other States with significant production of expanded perlite in 1972 included California, Colorado, Florida, Kentucky, Mississippi, New Jersey, Pennsylvania, and Texas.

Table 2.—Expanded perlite produced and sold by producers in the United States

State	1971				1972			
	Quantity produced (short tons)	Sold or used			Quantity produced (short tons)	Sold or used		
		Quantity (short tons)	Value (thousands)	Average value per ton		Quantity (short tons)	Value (thousands)	Average value per ton
California	23,512	23,250	$1,778	$76.45	21,227	21,221	$1,827	$86.12
Florida	17,547	16,741	909	54.32	19,124	18,249	1,001	54.84
Indiana	7,253	7,253	462	63.70	14,866	16,331	968	59.27
Kansas	716	716	(1)	(1)	767	767	59	76.71
Maryland	(2)	(2)	(2)	(2)	(2)	3,208	299	93.22
Massachusetts	1,294	1,210	159	131.41	(2)	(2)	(2)	(2)
Missouri	3,278	3,278	(1)	(1)	(1)	(1)	(1)	(1)
New York	3,569	3,515	284	80.72	5,739	5,739	469	81.76
Ohio	7,709	7,709	(2)	(2)	12,791	12,791	774	60.52
Pennsylvania	23,161	22,664	1,254	55.32	29,231	29,790	1,667	55.97
Texas	13,720	13,717	1,309	95.39	21,696	21,210	1,270	59.87
Other Eastern States [3]	232,405	230,560	13,856	[4] 58.15	257,668	252,742	14,662	58.01
Other Western States [5]	54,858	54,870	3,146	[6] 53.45	43,460	39,291	2,354	59.91
Total [7]	389,022	385,483	23,156	60.07	426,569	421,339	25,350	60.17

[1] Included with "Other Western States."
[2] Included with "Other Eastern States."
[3] Includes Georgia, Illinois, Kentucky, Louisiana, Maine, Maryland (1971), Michigan, Mississippi, New Hampshire, New Jersey, North Carolina (1971), Ohio (1971 value only), Tennessee, and Wisconsin.
[4] Based on quantity of 238,269 tons and value of $13,856,000 (230,560 tons "Other Eastern States" plus 7,709 tons for Ohio).
[5] Includes Arizona (1971), Colorado, Idaho, Iowa, Kansas (1971 value only), Minnesota, Missouri (1971 value only and 1972), Nebraska, Nevada, Oregon, Utah, and Washington (1971).
[6] Based on quantity of 58,862 tons and value of $3,146,000 (54,870 tons "Other Western States" plus 714 tons for Kansas and 3,278 tons for Missouri).
[7] Data may not add to totals shown because of independent rounding.

CONSUMPTION AND USES

Consumption of expanded perlite in the United States reached a record level of 421,000 tons in 1972. The percent disposition by end use is shown in table 3. As in 1971, filter aid, plaster aggregate, concrete aggregate, and insulation board (included with "Other" uses) were the principal domestic uses of expanded perlite. Compared with that of 1971, consumption of expanded perlite in filter aids, plaster aggregate, and low-temperature insulation each increased 2% in 1972 while use of expanded perlite in concrete aggregate decreased 2%. Use of expanded perlite in horticultural aggregates was 3% in 1972—the same as in 1971. "Other uses" totaled 57% compared with 60% in 1971 and included primarily insulation board, fillers, formed products, and smaller amounts of paint additives, texturing granules, charcoal base, refractories, and miscellaneous agricultural products.

Table 3.—End use of expanded perlite

(Percent)

Use	1971	1972
Filter aid	14	16
Plaster aggregate	10	12
Concrete aggregate	10	8
Horticultural aggregates	3	3
Low temperature insulation	2	4
Masonry and cavity fill insulation	1	(1)
Fillers	(2)	(2)
Formed products	(2)	(2)
Other [3]	60	57

[1] Less than 1%.
[2] Included with "Other" to avoid disclosing individual company confidential data.
[3] Includes insulation board.

PRICES

Producers sold crushed, cleaned, and sized crude perlite to expanding plants at an average price of $11.34 per short ton in 1972, and the portion used by producers in their own expanding plants was valued at an average of $11.50 per ton. The weighted average of both categories was $11.44 per ton which was the same value as in 1971.

Expanded perlite sold or used, according to expanders, had an average value of $60.17 compared with $60.07 per ton in 1971. However, average values by States in 1972 ranged from $32 to $144 per ton.

WORLD REVIEW

Greece.—Although 1972 production data for perlite in Greece were not available, production in 1971 was slightly lower than in 1970. The quantity of crude perlite ore produced in 1971 was 177,000 tons compared with 185,800 tons in 1970. Processed perlite in 1971 amounted to 104,500 tons compared with 117,600 tons in 1970. The quantity of perlite exported by Greece in 1970 and 1971 averaged 15% of crude ore production and 95% of processed ore production, respectively.

Philippines.—The quantity of perlite produced from the Legaspi City deposit of Trinity Lodge Mining Corp. was only 480 tons in 1972—a slight increase from the 1971 production of 457 tons.

TECHNOLOGY

Grefco, Inc., a subsidiary of General Refractories Co., initiated installation of air pollution control systems at its perlite processing plant in No Agua, N. Mex., and storage facilities in Antonito, Colo., in 1972. The estimated $1 million project was to be completed by mid-1973.

Two product development research projects, sponsored by the Perlite Institute, New York, were completed during the year. One project involved the durability characteristics of perlite cement plasters (stucco). The other study, in two parts, was concerned with the physical properties of perlite insulating concrete with added diatomaceous earth and hydrated lime, and the effect of moisture migration for various vent boards used in roof deck construction.

Crude Petroleum and Petroleum Products

By James G. Kirby,[1] David A. Carleton,[2] and Betty M. Moore[3]

The total demand[4] for petroleum products in 1972 exceeded the 6-billion-barrel mark for the first time, increasing from the 1971 level by 437 million barrels or 7.8%.

The high level of industrial activity, colder-than-normal weather, and the substitution of fuel oils for short supplies of natural gas and low-sulfur coals all contributed to the unusually high increase in domestic product demand of 7.9%. Refined products exports were down slightly from the 1971 level.

Domestic production of crude oil and natural gas liquids was unable to keep pace with the increased demand, and imports were increased 21.1% and stocks were reduced by 85 million barrels.

The Department of the Interior was able to satisfy court orders that had canceled leasing of areas off the Louisiana coast in 1971, and lease sales were held in September and December 1972. At yearend the Alaskan pipeline continued to be delayed by court orders pending resolution of environmental concerns.

The increasing volume of natural gas liquids recovered from natural gas has made it desirable to present data on these liquids with crude oil data, as these liquids are blended with refinery products and are similar to materials recovered from refinery gases.

The Bureau of Mines uses crude-oil production data (including field condensate) compiled by State agencies for those States that compile the information. Where such data are not available, monthly questionnaires are sent to all pipeline companies operating within the State. Annual canvasses and State agencies also provide supplemental information on the value of crude petroleum at wells, and the number of producing wells.

Individual refineries reported monthly receipts, input, stocks, refinery production, and deliveries. Data on both product stocks at refineries and pipeline and bulk terminal stocks are collected. These data are also published monthly. Annually, sales of fuel oils, asphalt and road oils by uses, and refinery capacity are canvassed.

Demand by Product.—*Gasoline.*—The domestic demand for motor gasoline increased 6.3% in 1972 to 2,333,777,000 barrels. Emission control devices added to new car engines to meet Federal Government standards have caused a sharp decline in efficiency, accounting, in part, for the sharp increase in demand. The demand for aviation gasoline continued the downward trend in both the domestic and export markets. Domestic demand declined 7.1% in 1972 to 16,628,000 barrels, and exports declined 57.3% to 529,000 barrels.

Distillate Fuel Oil.—Domestic demand for distillate fuel oil in 1972 was 1,066,049,000 barrels, compared with

[1] Industry economist, Division of Fossil Fuels—Mineral Supply (retired).

[2] Petroleum specialist, Division of Fossil Fuels—Mineral Supply.

[3] Statistical assistant, Division of Fossil Fuels—Mineral Supply.

[4] Certain terms as used in this chapter are more or less unique to the petroleum industry. Principal terms and their meaning are—

Total demand.—A derived figure representing total new supply plus decreases or minus increases in reported stocks. Because there are substantial secondary and consumers' stocks that are not reported to the Bureau of Mines, this figure varies considerably from consumption.

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.

971,316,000 barrels in 1971. The increase of 9.8% was the highest on record for this fuel. Distillate fuel oil in most instances has a low sulfur content that is able to meet the various metropolitan area sulfur standards and thus entered markets formerly reserved for coal and residual fuel oil. Industrial and utility users of natural gas had to switch to distillate fuel oils in some areas of the country during the last quarter of 1972 because of tight natural gas supplies.

Residual Fuel Oil.—Residual fuel oil total demand increased at the rate of 230,000 barrels daily in 1972 to 937,707,000 barrels, and about 90% of the growth was in the electric utility market. While residual fuel oil lost some markets to distillate fuel oil, it picked up others from coal and natural gas. Imported residual fuel oil supplied 68.0% of demand requirements in 1972; 34.3% of this imported oil had a sulfur content of less than 0.5%, while only 18.9% of the 1971 imports had a low sulfur content.

Kerosine.—Markets for kerosine continued to decline, and demand was down 5.7% in 1972. The total demand for the year was 85,943,000 barrels for uses other than jet fuel.

Jet Fuels.—The total demand for kerosine-type jet fuels increased 7.2% in 1972 to 294,041,000 barrels, but demand for the naphtha type declined 6.9% to 89,406,000 barrels. The military used 105,153,000 barrels of jet fuel in 1972, compared with 112,968,000 barrels in 1971.

Liquefied Gases and Ethane.—After 2 years of low growth, the demand for liquefied gases increased 12.4% in 1972 to 425,118,000 barrels. During the fourth quarter of the year, demand increased 14.0%. Excessive rains and cold weather in the midwest delayed crop harvests, and large amounts of propane were required to dry the grains for storage, in substitute for

Table 1.—Salient statistics of crude petroleum, refined products, and natural gas liquids in the United States

(Thousand 42-gallon barrels unless otherwise indicated)

	1968	1969	1970	1971	1972 p
Crude petroleum:					
Domestic production (including lease condensate)	3,329,042	3,371,751	3,517,450	3,453,914	3,455,368
World production	14,093,150	15,214,885	16,710,826	17,662,793	18,598,008
U.S. proportion..percent	24	22	21	20	19
Exports [1]	1,802	1,436	4,991	503	187
Imports [2]	472,323	514,114	483,293	613,417	811,135
Stocks, end of year	272,193	265,227	276,367	259,648	246,395
Runs to stills	3,774,360	3,879,605	3,967,503	4,087,809	4,280,863
Value of domestic product at wells:					
Total..thousands	$9,794,826	$10,426,680	$11,173,726	$11,692,998	$11,706,510
Average per barrel	$2.94	$3.09	$3.18	$3.39	$3.39
Total producing oil wells Dec. 31	553,920	542,227	530,990	517,318	508,443
Total oil wells completed during year (successful wells)	14,342	14,368	13,020	11,858	11,306
Refined products:					
Exports [1]	82,742	83,449	89,467	81,342	81,281
Imports (including unfinished oils and plant condensate) [3]	567,046	641,437	764,769	819,463	924,121
Stocks, end of year [4]	647,439	656,344	675,502	695,878	712,584
Completed refineries, end of year	284	281	279	282	277
Daily crude-oil capacity	11,740	12,074	13,020	13,437	13,775
Natural gas liquids:					
Production	550,311	580,241	605,916	617,815	638,216
Stocks, end of year	77,940	58,552	65,992	88,421	79,238
All oils:					
Total product and crude oil demand	4,990,467	5,249,056	5,463,259	5,638,853	6,076,288
Exports	84,544	84,885	94,458	81,845	81,468
Domestic demand	4,905,923	5,164,171	5,368,801	5,557,008	5,994,820

p Preliminary (except for crude production and value).
[1] U.S. Department of Commerce data.
[2] Reported to the Bureau of Mines.
[3] U.S. Department of Commerce data, 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.

natural gas which was in short supply. The demand for ethane increased 21.0% in 1972 to 106,201,000 barrels. More detail on liquefied gases and ethane can be found in the "Natural Gas Liquids" chapter.

Other Products.—This category includes refinery gas (still gas) used for fuel, asphalt, petrochemical feedstocks, petroleum coke, lubricating oils, special naphthas, miscellaneous products, road oil, and wax. Refiners used 170,993,000 barrels of still gas for fuel in 1972 and 14,678,000 barrels for petrochemical feedstocks. The domestic demand for asphalt increased 3.3% to 163,788,000 barrels (29,779,000 short tons). The demand for petrochemical feedstocks was strong in the domestic market, but exports declined. Domestic demand for the year increased 12.1% to 123,867,000 barrels, and exports decreased 15.3% to 4,457,000 barrels. Sales of marketable coke increased 10.5% in 1972. Exports increased 14.8% to 6,215,000 short tons, and domestic sales increased 7.0% to 7,074 million short tons. Domestic demand for petroleum coke, including 10,590,000 short tons of catalyst coke, was 17,664,000 short tons in 1972, an increase of 10.5%. The demand for lubricating oils increased 4.1% in 1972, but exports declined 6.0%. Domestic demand was 67,796,000 barrels, and exports comprised 14,995,000 barrels.

The total demand for special naphthas increased 7.0% in 1972 to 33,375,000 barrels. Domestic demand was 31,888,000 barrels and exports, 1,487,000 barrels. The domestic demand for road oil continued to decline in 1972. Demand was 7,538,000 barrels, down 11.2% from 1971. The domestic demand for petroleum wax increased 3.1% to 5,410,000 barrels, but exports declined 32.0% to 1,129,000 barrels. In addition to the above products refineries produced in small quantities a variety of products (petrolatum, medicinal oils, rust preventives, spray oils, etc.) which the Bureau of Mines grouped together as miscellaneous products. The domestic demand for these products in 1972 was 15,280,000 barrels, and exports were 1,062,000 barrels.

Shipments to U.S. Territories, Possessions, and Free Trade Zones.—Domestic demand, as defined in this chapter, refers to demand in all States of the United States. Shipments from the United States to territories, possessions, and free trade zones are included with exports. Any foreign receipts into these areas are not included in total imports shown.

Shipments from territories, possessions, or free trade zones to foreign countries are excluded from exports. Shipments from these areas into any State of the United States are included in import data.

Districts.—The Bureau of Mines reports production of crude petroleum and natural gas liquids and the number of wells drilled by States. Data for Louisiana, New Mexico, and Texas are also reported by districts.

New Mexico has two widely separated producing areas. The Southeastern district comprises mainly Lea, Eddy, Chaves, and Roosevelt Counties. The Northwestern district comprises mainly San Juan, Rio Arriba, Sandoval, and McKinley Counties.

Bureau of Mines producing districts in Texas correspond, with one exception, to the following grouping of the Texas Railroad Commission districts:

Bureau of Mines districts	*Railroad Commission districts*
Gulf Coast	Nos. 2 and 3.
West Texas	Nos. 7C, 8, and 8A.
East Proper	Part of No. 6 (East Texas field in Cherokee, Smith, Upshur, Rush, and Gregg).
Panhandle	No. 10.
Rest of State:	
North	Nos. 7B and 9.
Central	No. 1.
South	No. 4.
Other East Texas	Nos. 5 and 6 (exclusive of East Proper).

Separate production data are shown for the Louisiana Gulf Coast, including the offshore area.

Refinery operations are grouped by the Bureau of Mines into another set of districts called refining districts. These refining districts correspond with the grouping originated by the Petroleum Administration for War during World War II and called PAW districts (later changed to PAD districts).

PAD district	*Refining districts*
I—*East Coast*—	District of Columbia and Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, and Florida, and the following counties of New York: Cayuga, Tompkins, Chemung, and all counties east and north thereof; and the following counties of Pennsylvania: Bradford, Sullivan, Columbia, Montour, Northumberland, Dauphin, York, and all counties east thereof.
I—*Appalachian No. 1*—	West Virginia and those parts of Pennsylvania and New York not included in the East Coast district.

II—*Appalachian No. 2*—The following counties of Ohio: Erie, Huron, Crawford, Marion, Delaware, Franklin, Pickaway, Ross, Pike, Scioto, and all counties east thereof.

II—*Indiana-Illinois-Kentucky*—Indiana, Illinois, Kentucky, Tennessee, Michigan, and that part of Ohio not included in the Appalachian district.

II—*Oklahoma-Kansas-Missouri*—Oklahoma, Kansas, Missouri, Nebraska, and Iowa.

II—*Minnesota-Wisconsin-North Dakota-South Dakota*—Minnesota, Wisconsin, North Dakota, and South Dakota.

III—*Texas Inland*—Texas, except Texas Gulf Coast district.

III—*Texas Gulf Coast*—The following counties of Texas: Newton, Orange, Jefferson, Jasper, Tyler, Hardin, Liberty, Chambers, Polk, San Jacinto, Montgomery, Harris, Galveston, Waller, Fort Bend, Brazoria, Wharton, Matagorda, Jackson, Victoria, Calhoun, Refugio, Aransas, San Patricio, Nueces, Kleberg, Kenedy, Willacy, and Cameron.

III—*Louisiana Gulf Coast*—The following parishes of Louisiana: Vernon, Rapides, Avoyelles, Pointe Coupee, West Feliciana, East Feliciana, Tangipahoa, St. Helena, Washington, and all parishes south thereof; the following counties of Mississippi: Pearl River, Stone, George, Hancock, Harrison, and Jackson; and Mobile and Baldwin Counties, Ala.

III—*North Louisiana-Arkansas*—Arkansas and those parts of Louisiana, Mississippi, and

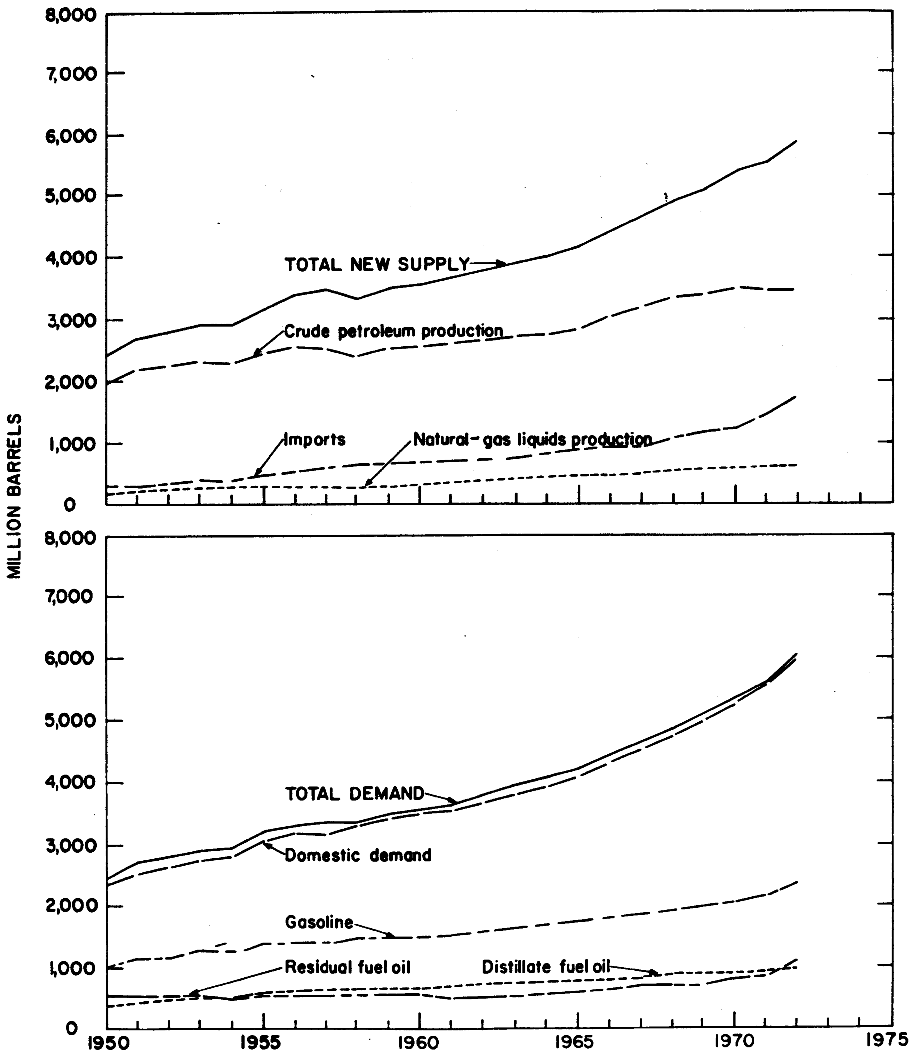

Figure 1.—Supply and demand of all oils in the United States.

Alabama not included in the Louisiana Gulf Coast district.

III—*New Mexico*—New Mexico.

IV—*Rocky Mountain*—Montana, Idaho, Wyoming, Utah, and Colorado.

V—*West Coast*—Washington, Oregon, California, Nevada, Alaska, Arizona, and Hawaii.

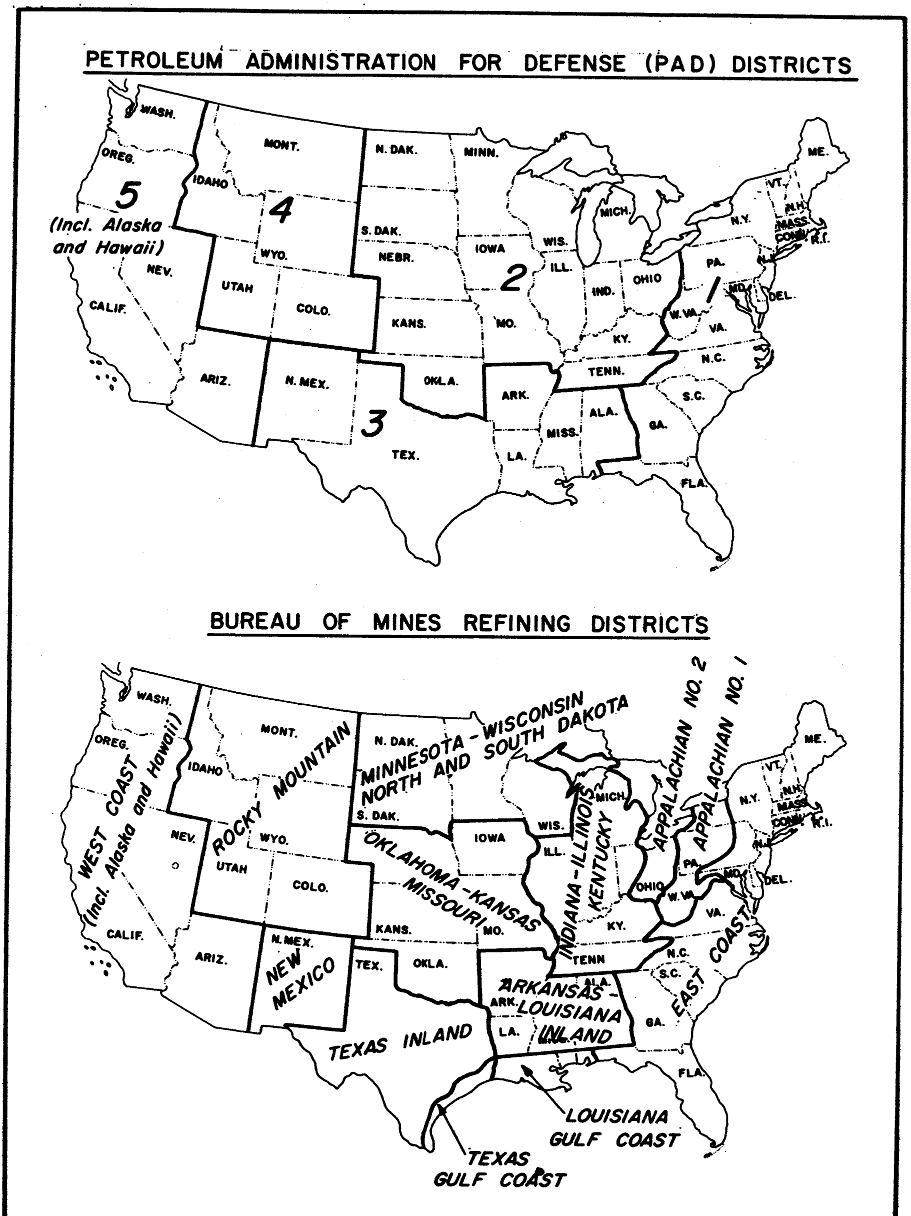

Figure 2.—Map of PAD Districts and Bureau of Mines Refining Districts.

CRUDE PETROLEUM

PRODUCTION

The production of crude oil (including lease condensate) in 1972 was 3,455,368,000 barrels, or a daily average producing rate of 9,441,000 barrels. For 1971, production was 3,453,914,000 barrels with a daily production average for the year of 9,463,000 barrels.

During the year, a tight supply situation developed, and several States with prorationing relaxed allowable rates in an effort to increase supply. Production in Texas for the year averaged 3,556,000 barrels daily compared with 3,350,000 barrels in 1971. As separation and desulfurization equipment was installed at new fields in northern Florida during the year, production increased from an average of 17,000 barrels per day in January to 83,000 barrels daily in December, and the daily average for the year was 46,000 barrels per day compared with 15,000 barrels in 1971. Production for the year increased at the rate of 12,000 barrels per day in Colorado, 6,000 in Alabama, 8,000 in Utah, and 3,000 in Michigan.

Production in 1972 declined at an average daily rate of 126,000 barrels in Louisiana, 34,000 in California, 23,000 in Wyoming, 17,000 in Oklahoma, 14,000 in Kansas, and 12,000 in Illinois.

CONSUMPTION

The total demand for crude oil in the United States in 1972 was 4,279,756,000 barrels, of which 3,472,432,000 was supplied from domestic sources, and 807,324,000 barrels came from foreign sources. The demand for domestic crude was down slightly from 1971, but the demand for foreign crude oil increased 33.0%.

Runs to Stills.—Refineries processed crude oil at an average daily rate of 11,696,000 barrels in 1972 and reached the highest daily level of operation in September when runs to stills averaged 12,113,000 barrels. Based on the total operable January 1, 1972, capacity, refineries operated at 88.0% of capacity in 1972.

Demand by State of Origin.—Distribution of domestic crude oil can be analyzed from the individual refinery reports which show origin of the crude oil receipts and from crude oil stock reports filed by refiners, pipeline companies, and terminal operators which show stocks of crude oil by States of origin and location. When long-distance shipments are involved, various crude oils may be mixed in transit or storage, and identification by origin may be only approximate.

SUPPLY AND DISTRIBUTION

The total distribution of crude oil in 1972 was 4,290.0 million barrels of which domestic crude oil accounted for 3,482.7 million barrels and foreign crude oil, 807.3 million barrels. The new supply of crude oil included 3,459.0 million barrels of crude oil and lease condensate produced in this country and 811.1 million barrels imported from foreign sources. Stocks of domestic crude oil declined 17.1 million barrels during 1972, but stocks of foreign crude oil increased 3.8 million barrels. The difference between supply and distribution, 10.2 million barrels, was classified as "unaccounted for" to avoid making arbitrary adjustments in the reported supply and consumption.

PRODUCTIVE CAPACITY

According to the American Petroleum Institute (API) the maximum crude oil production that could be attained in the United States as of January 1, 1973, was 10.3 million barrels daily, down 0.4 million barrels daily since January 1, 1972. This estimate was based on the assumption that such production could be achieved in 90 days with existing wells, well equipment, and present surface facilities, plus work changes that could be accomplished within that time. No production capacity was credited to the crude oil on the North Slope of Alaska since there was no way to market the oil, and installation of production equipment was incomplete.

WELLS

Drilling activity in 1972 increased for the first time since 1969 with 27,291 wells drilled, 1,440 more than in 1971. The drilling resulted in 11,306 new oil wells, 4,928 new gas wells, and 11,057 dry holes. The average depth of the wells drilled in 1972 was 4,932 feet, 126 feet deeper than the average in 1971.

States reporting the largest increase in drilling activity for the year were Texas with an increase of 395 wells drilled, Montana with 326, Pennsylvania with 260, New Mexico with 218, and Ohio with 174. In California, 410 fewer wells were drilled than in 1971.

Two lease sales were held by the Department of the Interior in 1972 for acreage off the Louisiana Gulf Coast, one in September and the other in December.

There were 508,443 oil wells producing at the end of 1972 compared with 517,318 on December 31, 1971.

RESERVES

The API Committee on Petroleum Reserves estimated reserves of crude oil as of December 31, 1972, to be 36,339 million barrels, a decline of 1,724 million barrels for the year. Only Florida, Michigan, Montana, and Utah reported additions to reserves during the year. Reserves declined 879 million barrels in Texas, 370 million barrels in Louisiana, 152 million barrels in California, and 102 million barrels in Oklahoma.

REFINED PRODUCTS

At yearend 1972, transportation bottlenecks occurred in some areas because of the inability of domestic crude oil production and refining capacity to keep pace with unprecedented demand. Little refinery expansion occurred in 1972. In addition, imports of foreign sweet crude oil and finished products were limited because of in-

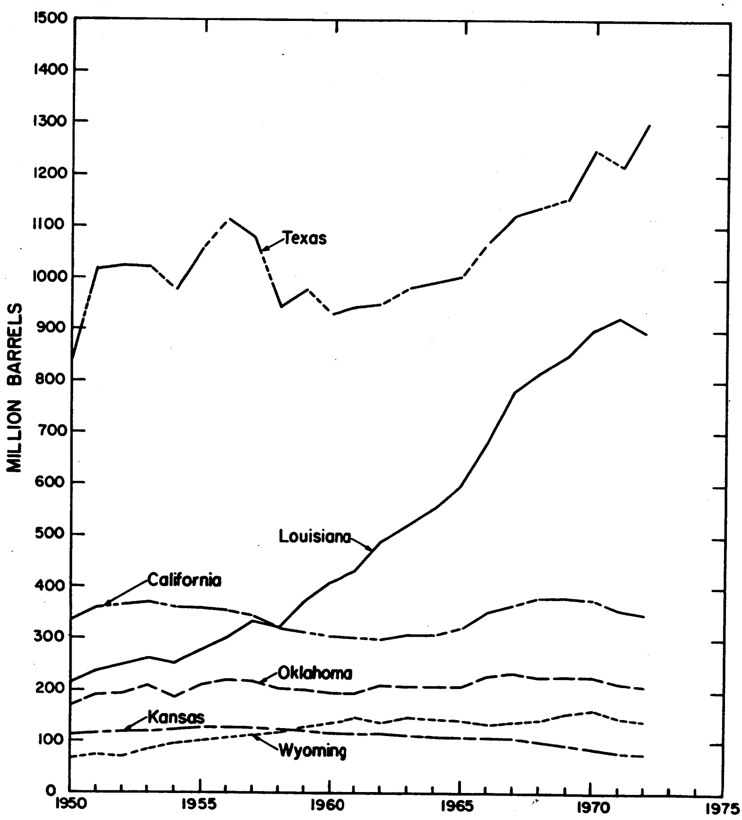

Figure 3.—Production of crude petroleum in the United States, by principal producing States.

creasing worldwide competition for quality fuels, and the United States lacked adequate dock and terminal facilities to handle expanded imports. Several inland refiners, especially those limited to refining sweet crude oil, had difficulty obtaining supplies and had to cutback on refinery operations. Higher cost of foreign crude oil, as a result of negotiations by the foreign governments and the devaluation of the dollar, eliminated much of the trading value of import tickets between inland and coastal refiners.

Gasoline was consumed principally in highway transport, aviation, mechanized farming, and power boating. Kerosine (other than the straight-run kerosine used as fuel in commercial jet aircraft) was used primarily in space heaters, as range oil, or for farm equipment. Distillate fuel oils, which include the light diesel fuels, were consumed for space heating, locomotive fuel, industrial use, electric utility use, vessel use, and military uses. Residual fuel oil was used primarily in electric utilities and for heavy-fuel use. Residual fuel is not normally moved by pipeline; its distribution depends on low-cost water transportation and limited tank movement.

Liquefied gases, in competition with kerosine and light distillate fuel oil for domestic use, were used as fuel in internal-combustion engines and were becoming increasingly important as the initial raw material in the development of many petrochemicals.

The total demand for petroleum products averaged 16,589,000 barrels per day in 1972, including a domestic demand of 16,367,000 barrels per day and exports of 222,000 barrels per day. Compared with 1971, total demand increased 7.8%, domestic demand increased 7.9%, and exports remained at the same level.

Total supply for the year averaged 16,370,000 barrels daily, and after allowing for crude oil losses and exports there was a decline in stocks in all oils averaging 232,000 barrels daily for the year.

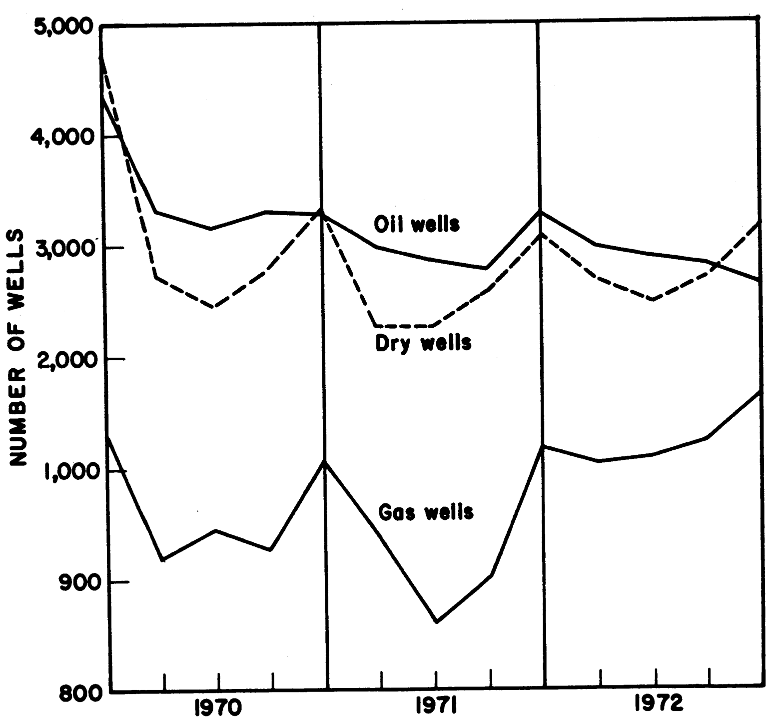

Figure 4.—Wells drilled for oil and gas in the United States, by quarters.

GASOLINE

The domestic demand for motor gasoline increased 6.3% in 1972 to 2,333,777,000 barrels, the highest increase reported since 1968. The high level of the general economy, which boosted new car sales to record levels, and the reduced efficiency of new car engines because of federal air emission standards and other equipment sent demand soaring. To keep up with the heavy demand, refineries maintained high yields of gasoline much later in the season than normal and entered the winter heating season with low stocks of distillate fuel oils which created spot shortages in some areas.

The new supply of motor gasoline in 1972 was 2,328 million barrels of which 1,986 million barrels was produced from crude oil, 307 million barrels from natural gas liquids, and 10 million barrels from other hydrocarbons and hydrogen; 25 million barrels was imported.

According to data compiled by API based on tax data reported by the States, 2,387 million barrels of motor gasoline was consumed in the United States in 1972 compared with 2,236 million in 1971. This differs from the demand data compiled by the Bureau of Mines, which do not include changes in secondary storage.

Aviation gasoline demand continued to decline in 1972 as it has for the past 14 years, and domestic demand was 16,628,000 barrels compared with 17,892,000 barrels in 1971.

KEROSINE

The markets for kerosine continued to decline in 1972, and demand was off 5.7%. Domestic demand was 85,854,000 barrels compared with 90,917,000 in 1971. The primary use for kerosine was for space heating, which represents about 78% of demand, but it is being replaced by more convenient fuels such as bottled gas (propane) and electricity.

DISTILLATE FUEL OIL

The 9.8% gain in domestic demand for distillate fuel oil in 1972 was attributed to colder-than-normal weather, the high level of industrial activity, and substitution for other fuels in areas where air quality restrictions limit the use of fuels with higher sulfur content, and where natural gas was in short supply. Domestic demand for the year was 1,066,049,000 barrels compared with 971,316,000 barrels in 1971. Exports declined from 2,761,000 barrels in 1971 to 1,214,000 barrels.

Meeting the strong demand for both gasoline and distillate fuel oil created problems for refiners in 1972. Some inland refiners had difficulty obtaining particular types of crude oil suited to their refineries and in some cases had to limit crude runs. The changeover from high yields of gasoline to distillate fuel oil was delayed until late fall, and stocks at the beginning of the 1972–73 heating season were uncomfortably low. Fortunately, the exceptionally cold weather of October and November did not continue. Controls were relaxed to permit more imports and refiners concentrated on higher production of distillate fuel oil, so that except for a few spot shortages in some areas, demand was met for the 1972–73 season.

The new supply of distillate fuel oil in 1972 was 1,030,960,000 barrels, an increase of 6.3% or 61,532,000 barrels more than in 1971. To meet the total demand requirements, 36,303,000 barrels were withdrawn from stocks.

RESIDUAL FUEL OIL

Residual fuel oil demand lost out in some heating and industrial markets because of air quality regulations, but the gain in the electric utility market was so high that the overall increase in the domestic demand for residual increased 10.5%. A strong factor in the growth was the increase in the new supply of low-sulfur residual fuel oil from domestic and foreign sources. About 34% of the residual fuel oil imported (exclusive of fuel for bunkering) had a sulfur content of 0.5% or less, while only 19% of the 1971 imports had this low a sulfur content. Over 22% of the residual produced in U.S. refineries in 1972 had a sulfur content of 0.5% or less, compared with 18% in 1971.

Electric utilities used 493,927,000 barrels for the generation of electric power in 1972 compared with 362,022,000 barrels in 1971.

The total demand for residual fuel oil in 1972 was 937,707,000 barrels including a domestic demand of 925,647,000 and exports of 12,060,000 barrels. The new supply for the year totaled 933,242,000 barrels of which 68.3% was imported. To meet demand, 4.5 million barrels were withdrawn from stocks.

JET FUELS

Jet fuel demand increased 3.6% in 1972, slightly below the 1971 increase of 3.9% and well below the 13% annual growth rate of the 1960's. Airline efforts to curtail some flights and establish a greater utilization of existing seating capacity was instrumental in limiting demand growth. In addition, military use was down. The demand for kerosine-type jet fuel increased 52,000 barrels per day during 1972 to 803,000 barrels. Demand for the naphtha-type jet, used primarily by the military, after having increased only slightly in 1971, continued its overall decline by falling to 244,000 barrels per day in 1972.

Imports of jet fuel averaged 194,000 barrels per day in 1972 of which 164,000 barrels was imported in bond for use as fuel for aircraft engaged in flights with destinations outside the United States. There is no custom duty on these imports, and bonded imports of such fuels were not subject to import control regulations.

LUBRICANTS

The total demand for lubricants in 1972 increased 4.1% to 67,796,000 barrels. The

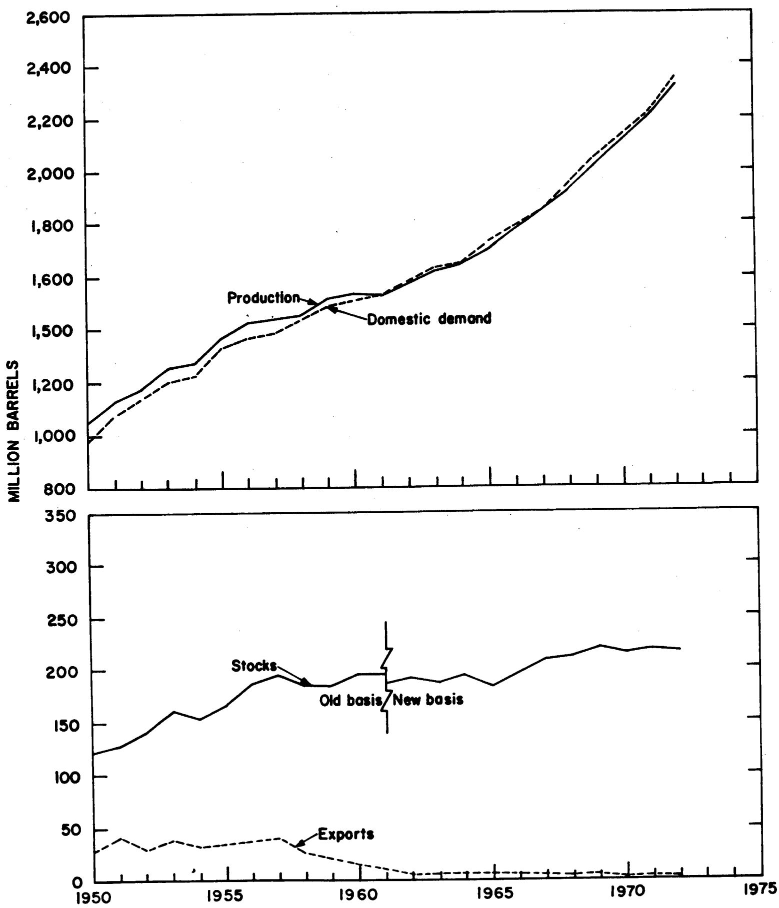

Figure 5.—Production, domestic demand, stocks, and exports of gasoline in the United States.

gain for the year was all in the domestic market, which was 52,801,000 barrels compared with 49,321,000 in 1971. Over half of the domestic sales of lubricants were for industrial use and the demand reacted to the level of industrial activity, which was up sharply in 1972.

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 produced from natural gas. The liquefied petroleum gases (LPG) are all saturated (propane, butane, etc.). The liquefied refinery gases (LRG) may contain unsaturated compounds or olefins (propylene, butylene, etc.). The olefins are used as feedstocks for chemical plants. The saturated gases may be used as chemical raw materials or as fuel.

Separate data were collected on liquefied refinery gas used as fuel and that used as raw material for petrochemical feedstocks. Liquefied gases were also used in producing gasoline and are reported in this chapter as natural gas liquids at refineries or as gasoline.

Total demand for liquefied gases, excluding that blended into other products at refineries or terminals in 1972 was 425,118,000 barrels compared with 378,398,000 barrels in 1971. Domestic demand for the year increased 12.1%, and exports increased 22.1%. Through the first 9 months of 1972, domestic demand showed a significant gain over that of the same period of 1971, and in the last quarter it soared to 18.3%. Wet weather in the midwest farm belt delayed the crop harvest. Normally grain elevators use natural gas to dry the grain, but exceptionally cold weather caused a shortage of natural gas so that it was necessary to substitute liquefied gases to dry the grain.

The demand for ethane (including ethylene) was 106,201,000 barrels in 1972 compared with 87,744,000 barrels in 1971.

ASPHALT AND ROAD OIL

Shipments of asphalt and asphaltic products in the United States in 1972 were 31,121,000 short tons compared with 30,023,000 short tons in 1971. Asphalt for paving, which represents 77.4% of the total sales, was 24,100,000 short tons, up slightly from the 23,821,000 short tons sold in 1971. Shipments of roofing products increased a significant 20.3% in 1972 to 5,248,000 short tons, while shipments for all other products declined 3.6%. The shipment data include, in addition to refinery production and imports, various emulsifiers and blenders.

The domestic demand for asphalt in 1972 was 29,779,000 short tons, an increase for the year of 3.3%.

The demand for road oil decreased from 8,487,000 barrels in 1971 to 7,538,000 barrels in 1972.

OTHER PRODUCTS

Special Naphtha.—Special naphthas were used primarily for paint thinners, cleaning agents, and solvents. The domestic demand for special naphthas increased 7.1% in 1972 to 31,888,000 barrels, while exports increased 2.2% to 1,487,000 barrels.

Waxes.—The domestic demand for petroleum wax increased 3.1% in 1972 to 757,400 short tons, but exports declined 74,340 tons to 158,060 short tons so total demand for the year was off 5.3%. The annual survey of wax sales conducted by the API for 1972 represents about 79% of the domestic demand reported by the Bureau of Mines. A breakdown of the 1972 data, by end use and percentage change, from 1971 is as follows: Paperboard containers, 122,905 tons, down 5.6% paper wrappers, 95,678 tons, up 2.2% corrugated paperboard, 78,163 tons, up 8.8% candles, molded novelties, and decorative items, 103,601 tons, up 20.7%, and all other uses, 196,702 tons, up 9.1%.

Coke.—Domestic demand for petroleum coke increased 10.5% in 1972 to 17,664,000 short tons, while exports increased 14.8% for the year to 6,215,000 short tons; the result was that total demand was up a significant 11.6%. Refineries used 11,231,000 short tons as fuel in 1972, including 11,064,000 short tons of catalyst coke and 167,000 short tons of marketable coke. Catalyst coke is formed in the catalytic cracking units in the refining process and can only be used as a refinery fuel.

Still Gas.—Refineries used 1,046,492 million cubic feet of still gas as fuel in 1972, 6.6% more than in 1971. Still gas used as petrochemical feedstocks in 1972 totaled 14,678,000 barrels, 9.2% less than in 1971.

Petrochemical Feedstocks.—In addition to liquefied gases and ethane petroleum refineries supplied the United States petrochemical industry with 123,867,000 barrels of other feedstocks in 1972. This was an increase of 12.1% over the 1971 total. Exports declined 15.3% for the year to 4,457,000 barrels.

Unfinished Oils.—Unfinished oils are oils that have been partially refined and will be further processed by a refinery. The rerun (net) of unfinished oils represents the receipts of domestic or foreign oil plus or minus the stock change.

Miscellaneous Finished Products.—The petroleum industry produces a variety of miscellaneous products that are sold directly to consumers or in bulk to specialty companies which package and distribute them under various trade names. Included in this category would be absorption oils, medicinal oils, insecticides, petrochemicals and solvents. The domestic demand for these products in 1972 was 15,280,000 barrels.

TRANSPORTATION AND DISTRIBUTION

CRUDE OIL

A transportation system consisting of pipelines, tankers, barges, tank cars, and tank trucks moves the crude petroleum to refineries for processing. Refineries received 76.7% of their crude oil supply by pipeline, 22.1% by water, and the remaining 1.2% by tank cars and tank trucks in 1972.

States in PAD district I accounted for 39% of the petroleum product domestic demand in the United States. Refineries in this district supplied about 24% of the product demand. The supply of crude oil processed at these refineries in 1972 was 74% foreign; 22% was from other PAD districts, and 4% from within the district. PAD district II, the second largest consuming district, was also a deficit producing and refining area; however, output of refineries in that district represented 81% of demand in 1972. About 31% of the crude oil processed in refineries in PAD district II was produced in that district, 47% was received from PAD district III, and 8% was from PAD district IV; 14% was imported from foreign sources. Both PAD districts III and IV produced and refined petroleum in excess of their demand requirements and helped meet the supply deficits of other districts.

The refined products produced at refineries in PAD district V in 1972 represented almost 94% of the domestic product demand for that district. Crude oil produced in the district supplied 62% of refinery input, and foreign crude oil, 36%; 2% was received from other PAD districts.

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, and 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.

Total receipts of crude oil at refineries in 1972 were 4,279.2 million barrels, an increase of 198.4 million barrels for the year. Receipts from domestic sources increased 3.0 million barrels in 1972, overland receipts of foreign crude oil (from Canada) were 46.8 million barrels higher, and foreign receipts from overseas sources increased 148.6 million barrels.

More overseas foreign crude oil entered the midwest and gulf coast refineries in 1972 because domestic crude oil was in short supply, and exchanging of foreign quotas for domestic crude oil became more difficult.

Refineries processed 4,280.9 million barrels of crude oil in 1972, reported a net of 1.1 million barrels used for refinery fuel and losses, and withdrew 2.8 million barrels from stocks.

REFINED PRODUCTS

Domestic demand for petroleum products averaged 16,367,000 barrels daily in 1972, a record gain of 7.6% above the 15,213,000 barrels daily for 1971. The demand, broken down by PAD districts, is as follows: District I, 6,459,000; district II, 4,462,000; district III, 2,851,000; district IV, 436,000; and district V, 2,159,000.

PAD district I imported an average of

2,078,000 barrels daily of refined petroleum products in 1972 and received 2,926,000 barrels daily from other districts. Shipments from PAD district I to PAD district II averaged 141,000 barrels daily, and 21,000 barrels per day of petroleum products were exported.

PAD district II received an average of 759,000 barrels daily of refined products from other districts and imported 64,000. The district shipped 60,000 barrels daily to PAD district I and 73,000 barrels daily to PAD district III, and exported 10,000 barrels daily.

PAD district III shipped an average of 2,863,000 barrels daily of refined petroleum products to PAD district I, 594,000 barrels daily to PAD district II, 27,000 barrels daily to PAD district IV, and 63,000 barrels daily to PAD district V and exported 104,000 barrels daily. The district received 73,000 barrels per day of refined products from PAD district II and imported 45,000 barrels daily from foreign sources.

PAD district IV shipped an average of 105,000 barrels daily of refined petroleum products to other districts, received 53,000 barrels daily from other districts, and imported 15,000 barrels daily.

PAD district V received an average of 63,000 barrels daily of refined products from PAD district III and 81,000 barrels daily from PAD district IV, and imported 112,000 barrels daily. PAD district V shipped 3,000 barrels daily to PAD district I and 26,000 barrels daily to PAD district IV, and exported 87,000 barrels daily.

PIPELINES

As of January 1, 1971, there were 218,604 miles of pipelines transporting crude oil and refined products in the United States. This represents an increase of 9,126 miles from the total reported in the previous Bureau of Mines survey for January 1, 1968. The mileage of gathering lines declined 2,992 miles during the 3-year period; crude trunkline mileage increased 48,241 miles and 7,877 additional miles were reported for product pipelines.

Crude oil pipelines delivered 3,281.6 million barrels to refineries in 1972 compared with 3,094.9 million barrels in 1971. Petroleum products pipelines delivered 2,967.9 million barrels in 1972, an increase of 323.1 million barrels for the year.

The total crude oil required for pipeline fill as of January 1, 1971, was 73,642,000 barrels. Line fill for product pipelines required 39,908,000 barrels.

RAIL, TANK TRUCK, BARGE AND TANKERS

According to the annual study of the Association of Oil Pipelines, the total tonnage of crude petroleum and petroleum products transported in 1971 was 1,719,813,000 short tons of which 46.9% was moved by pipelines, 24.2% by water carriers, 27.4% by motor carriers, and 1.5% by railroads. Petroleum products represent 64.2% of the total volume transported, 43.0% of the pipeline movements, 72.5% of the water carrier movements, 91.3% of motor carrier movements, and 96.6% of the railroad movement.

STOCKS

Stocks of all oils at the end of 1972 totaled 959.0 million barrels, the lowest year-end level since 1967. The decline for the year was 85.0 million barrels, of which refined products stocks were down 65.8 million barrels and stocks of crude oil were down 13.2 million barrels. Of deep concern were stocks of distillate fuel oil which had declined 36.3 million barrels during 1972 and were at the lowest December closing level since 1966. Fortunately, because of warmer-than-normal weather during the first quarter of 1973, and the fact that refiners concentrated on a high distillate fuel oil output, serious shortages were averted in the 1972–73 heating season.

A tight crude oil supply situation developed in the last half of 1972 and some refiners had to cutback operations. By year-end, crude oil stocks declined to 246.4 million barrels, the lowest level since 1966.

PRICES

Crude Oil.—With the exception of a few changes in December for Pennsylvania-grade crude oil, there were no changes in posted prices in 1972. The average value of crude oil at the wellhead in 1972 was $3.39 per barrel, the same as in 1971.

Refined Products.—The price controls in effect in 1972 kept refinery prices at the August 1971 level through most of the year, and though there were some upward adjustments in distillates and lubricating oils late in 1972, average refinery prices were down slightly from 1971. Tanker rates were below the 1971 levels, and this was reflected in the decline in posted prices for the heavy fuel oils at the seaboard.

The average price of regular-grade gasoline at service stations, based on 55 representative U.S. cities, was down 0.7 cent per gallon in 1972, but State and local taxes increased 0.4 cent per gallon so the average price to the consumer declined only 0.3 cent for the year.

When price controls went into effect in August 1971 stocks were at a high level and product prices were low. Motor gasoline was still in the peak summer demand period when prices are normally higher, but for heating oil this was still within the months that discounts are used as an incentive to encourage summer fill-up of customers' storage facilities to ease peak winter demands. The low price base for distillates was cited as one of the reasons refiners delayed adjusting refinery production from gasoline to distillate fuel oil until later in the 1972 season.

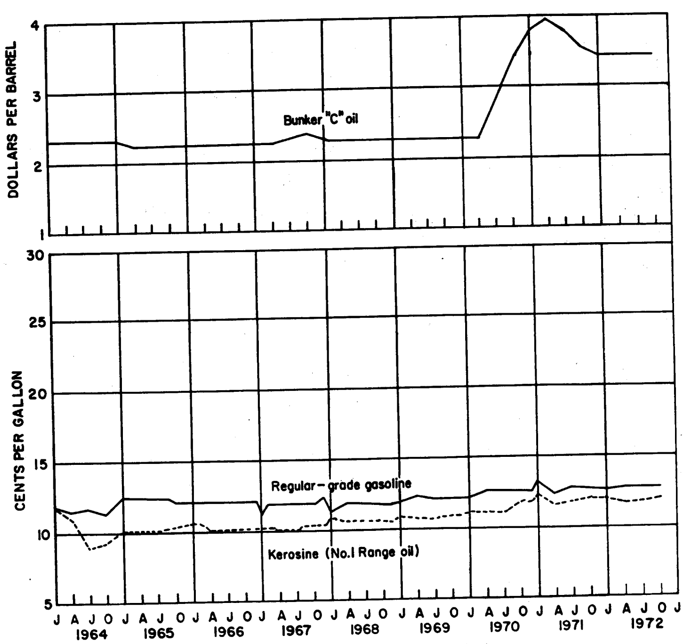

Figure 6.—Prices of Bunker "C" oil at New York Harbor, No. 1 Range oil at Chicago district, and regular-grade at refineries in Oklahoma, by quarters.

FOREIGN TRADE

Imports of crude oil and refined products totaled 1,735.3 million barrels in 1972 compared with 1,432.9 million in 1971. Crude oil accounted for 197.7 million barrels of the 302.4-million-barrel increase. About midyear it became apparent that domestic crude oil production could not be increased enough to meet demand requirements, and it was necessary to adjust import quotas upward.

Crude oil imports for the year were 811,135,000 barrels of which 38.5% was from Canada, 13.5% from other Western Hemisphere countries, 21.2% from Africa, 19.3% from the Middle East, and 7.5% from other Eastern Hemisphere countries.

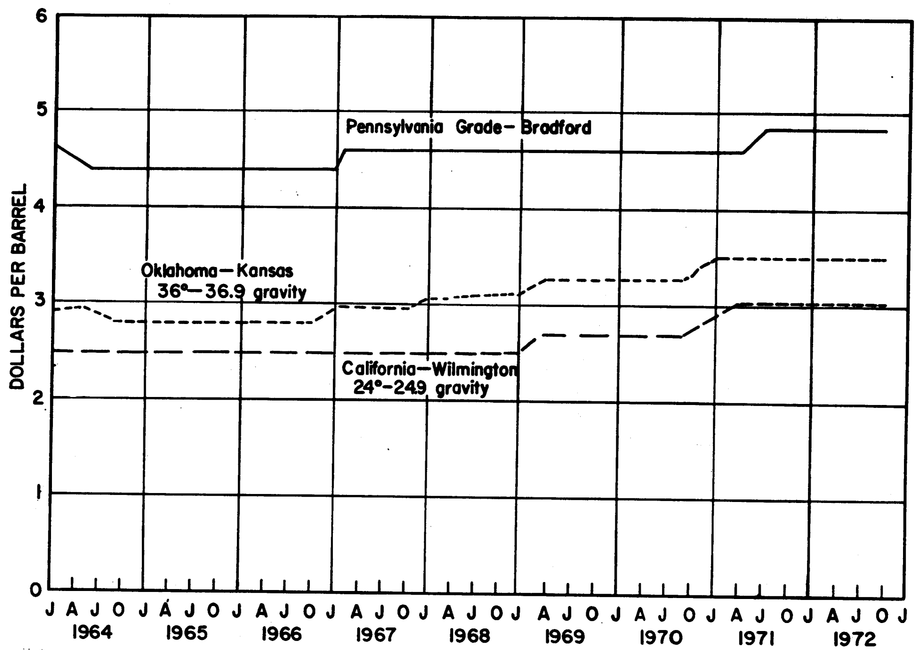

Figure 7.—Posted prices of selected grades of crude petroleum in the United States, by quarters.

Canada supplied 99.5% of the natural gasoline and condensate imported into this country in 1972, and other Western Hemisphere countries supplied the rest of the 31,428,000 barrels.

Unfinished oils imported for further refining in 1972 totaled 45,705,000 barrels, and these were primarily from South American and the Caribbean.

Refined product imports for the year were 846,988,000 barrels. Canada supplied 7.3%; other Western Hemisphere countries, 81.4%; Europe, 7.6%; Africa, 1.3%; the Middle East, 1.4%; and other Eastern Hemisphere countries, 1.0%. Included in the total refined petroleum product imports were 59,980,000 barrels of jet fuels, 5,296,000 barrels of distillate fuel oil, and 40,769,000 barrels of residual fuel oil which were withdrawn from bond for use as fuel for aircraft and vessels engaged in overseas commerce. These imports were exempted from oil import controls and from tariff duties. Residual fuel oil imported by the military for offshore use in 1972 totaled 5,035,000 barrels. This use by the military was exempt from import control regulations, but other imports by the military were under quota or license.

Exports of petroleum in 1972 were 81,468,000 barrels which was slightly below the 1971 level. There was a strong export market for petroleum coke and liquefied gases which offset much of the declines for the other products.

The international tanker market in 1972, though less volatile than in 1971, reflected worldwide marketing conditions. Freight rates continued the decline which near the end of 1970 had reached the lowest level since early 1967. By midspring the single-voyage (spot) tanker market, according to a London-based chartering service, flatten-out at about Worldscale 55, almost 100 Worldscale points below the spring 1971 level. Worldwide demand for oil was still below its normal growth rate, and the second mild winter left petroleum marketers overstocked with crude. Some relief came in mid-1972 shortly following a 3-month strike by Japanese seamen and the interruption of crude oil production by the nationalization of most Iraq Petroleum Co., Ltd., holdings in Iraq. The upturn continued through the remainder of 1972 as world demand was up and the United States became more dependent on imports. At yearend spot market rates were about 12.5% Worldscale.

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, and most was shipped to a refinery in Colorado and converted into petroleum products. The total production of native asphalts and related bitumens in 1972 was 1,995,374 short tons with a value of $10,303,000.

WORLD REVIEW

During 1972 much of the petroleum consuming and producing world developed a growing awareness of an impending energy crisis. This was highlighted by fuel shortages in several marketing areas and associated supply and financial problems.

Price and ownership disputes and agreements continued to feature the confrontations between the major international oil companies and members of the Organization of the Petroleum Exporting Companies (OPEC). A major price adjustment early in the year reflected the devaluation of the U.S. dollar in 1971.

World crude oil production in 1972 increased 5.3% to a total of about 50.8 million barrels per day. This compares with a 5.7% increase in 1971. Production increases in the Eastern Hemisphere were lower than in the past because of certain restraints. Kuwait joined Libya in limiting production for conservation purposes. Output in Iraq was hindered by the nationalization of most of the country's production capacity. In addition major union strikes in Japan and Australia affected production in Abu Dhabi and other Middle East countries.

Exploration and development drilling increased after several years of decline. Most of the increase was in the United States where wells drilled increased 5.5%. Other areas of significant exploration were the Canadian Arctic, the northern parts of the North Sea, Saudi Arabia, Peru, Egypt's western desert, west-central Africa, offshore northwestern Australia, and Indonesia.

Algeria.—The Algerian state oil company Société Nationale pour la Recherche, la Production, la Transport, la Transformation, et la Commercialisation des Hydrocarbures (SONATRACH) was successful during the year in obtaining customers, including several foreign countries and the major international oil companies, for its nationalized oil production. Algeria nationalized essentially all of its production in 1971, and it was doubtful whether SONATRACH could market all of its output. Unique among the recent agreements was SONATRACH's long-term contract with Commonwealth Oil Refining Co. (Corco). The pioneering $8 billion, 25-year contract calls for the delivery to Corco of 380 million tons (about 2.9 billion barrels) of crude oil and other hydrocarbon materials.

Angola.—Crude oil shipments commenced from the new Cabeca da Cobra field located about 25 miles from the port of Santo Antonio do Zaire. Operated by a subsidiary of Petrofina, Inc., for a group of Belgian, Portuguese, and U.S. companies, the field started production from 10 wells at a rate of 1,800 barrels per day.

Argentina.—During the year the Government approved a $170 million expansion program for Yacimientos Petrolíferos Fiscales (YPF). The program included substantial increases in exploration, production, and refining. Crude oil production is to be raised to 550,000 barrels per day. Included in the program is further exploration and development on Tierra del Fuego and in the Santa Cruz-Condor area and refinery expansion in the Buenos Aires area.

Austria.—Attempts by the state company Österreichische Mineralölverwaltung, A. G. (ÖMv) to find new sources of oil was concentrated in drilling efforts abroad; however, the results were not promising. The well drilled in the Tunisia's Gulf of Hammamet was dry, but seismic surveys are scheduled for 1973. Other drilling resulted in the discovery of gas in Iran and Austria.

Bahamas.—A $35 million port and oil tanker terminal capable of handling up to 350,000-deadweight-ton tankers and over 400,000 barrels per day is scheduled for completion in 1974. The project is a joint venture of the Bahama Government and a private U.S. firm.

Expansion of the 250,000-barrel-per-day Freeport refinery will increase the capacity to 500,000 barrels per day. The plant, which is scheduled for completion in early 1973, will have a throughput capacity larger than any in the United States.

Bahrain.—A $90 million drydock for tankers of up to 300,000 deadweight tons, to be built by the Organization of Arab Petroleum Exporting Countries (OAPEC), is to be located in Bahrain. Cost of the project, which is to begin in 1973, will be shared 60% by OAPEC member states and 40% by Portuguese and Japanese companies.

Brazil.—Production was slightly below the 1971 level and the offshore Sergipe field was not expected to go into operation until mid-1973. Reportedly, the Guaricema and Caioba fields will produce about 60,000 barrels per day at that time and only the Atalaia producing platform needs to be completed.

Canada.—Whereas many natural gas discoveries have been reported in the Mackenzie Delta of northwestern Canada, the first oil discovery in the delta in 3 years was made in September 1972. Oil of 24° API gravity was encountered in several sands. Exploration in the Atlantic Ocean southwest of Sable Island resulted in a third gas find. Flow rates from five productive zones ranged from 5 to 21 million cubic feet per day and three zones tested 120 barrels per day of 46–48° API gravity condensate.

An agreement was signed in November 1972 between the provincial government of Nova Scotia and Shaheen Natural Resources for the construction of a 200,000-barrel-per-day refinery on the Strait of Canso to be completed in 1974–75. The plant will be the biggest in Canada, and Shaheen will be the country's third largest refiner. Completion of the agreement is subject to a firm, long-term supply contract and a satisfactory construction price. The complete project is estimated to cost $223 million. Shaheen's other refinery, the 100,000-barrel-per-day Come-by-Chance refinery, is due onstream in 1973. It was forecast by several large Canadian oil companies in testimony before the Alberta Energy Board that synthetic crude oil production from Alberta tar sands should reach 1.0 million barrels per day by 1985 and 3.5 million barrels per day by the end of the century.

China, People's Republic of.—Under a current 5-year trade agreement, Romania is to deliver 30 drilling rigs per year, each capable of reaching 16,400 feet, indicating the People's Republic of China's increasing interest in finding new reserves. Production of crude oil and shale oil in 1972 was about 30 million tons (600,000 barrels per day). In addition, the Chinese were preparing to drill offshore in the Gulf of Pohai where chances of finding oil are rated high. A four-legged, self-elevating drilling barge is to be delivered in March 1972 by a Japanese firm. A U.S. geologist estimated that the country's recoverable crude oil reserves in established oil-bearing areas at 19.6 billion barrels which, if fully developed, would allow a production of 2,700,000 barrels per day.

Columbia.—Production of crude oil was down considerably in 1972 because of conservation measures and dwindling reserves. An arbitration board determined that the Putumayo field was being overproduced, and the Government ordered the company to cut production from 70,000 to 30,000 barrels per day. Production from most other fields continued to decline, and no new discoveries seem likely to reverse the trend. The only new field discovery was in the Upper Magdalena area and tested less than 1,000 barrels per day.

Congo (Brazzaville).—In March, production from the offshore meraude Marine field started at an initial rate of 100,000 barrels per day and was expected to reach 500,000 barrels per day by 1974. The field was discovered in 1969 and has presented many problems because of its heavy crude oil. The only other field is the onshore Pointe Indienne oilfield, where production has declined from 14,000 barrels per day to less than 500 barrels per day.

Denmark.—Dan oilfield, Denmark's first, located 160 miles offshore in the North Sea started production on July 4. Initial production was about 8,000 barrels per day; however, the producing platform is capable of handling up to 30,000 barrels per day in case nearby geological structures prove to have commercial reserves. Production was tankered to coastal refineries. The producing company, Dansk Undergrunds Consortium (DUC), is required to deliver the main share of Dan production to Denmark. Later in the year DUC announced that it would attempt to stimulate the production capability of the oil-bearing chalk formation in the field, which was experiencing production difficulties. DUC also planned to drill five exploration wells, four of which would be offshore.

Ecuador.—During August the first shipment of crude oil from the Oriente region of Ecuador was delivered via a 318-mile pipeline to the deepwater terminal at Balao near the port of Esmeraldas. This marked the beginning of Ecuador's role as a major Latin American oil exporter. Exports averaged 200,000 barrels per day at yearend.

The Ministry of Natural Resources announced that the joint operations of Texaco Petroleum Co. and Ecuadorian Gulf Oil Co. had drilled 115 wells in their concession area in the Oriente region of Ecuador since they began exploration there 5 years ago and that 104 of these were producing wells. This group is Ecuador's major producer.

The latest in a series of regulation changes designed to tighten control of the Nation's oil industry occurred in 1972. Main items in the new rules include the relinquishment of 60% of each company's concession area within 12 months, a 15% surcharge on the f.o.b. value of crude oil exports, and the requirement that all companies operating in Ecuador renegotiate their contracts with the Government. In addition tax reference prices were introduced. Government income from oil exports is estimated now at $1.40 per barrel.

Egypt, Arab Republic of.—Production from existing fields (excluding those operated by Israel in occupied Sinai) continued to decline. This was due primarily to declining pressure at the country's largest oilfield, El Morgan field in the Gulf of Suez. However, production is expected to increase in the near future as a 300,000-barrel-per-day water injection project is being installed at El Morgan. It will be one of the world's largest waterflood pressure maintenance projects and will cost more than $30 million. A new field in the Western Desert came onstream during 1972 at a rate of 10,000 barrels per day, and two other Western Desert fields (one 20,000 barrels per day) were scheduled for production in early 1973.

The Government also offered a new invitation to foreign companies to explore for oil in the Arab Republic of Egypt. Agreements of the production-sharing or service-contract type with flexible terms are envisaged. A number of U.S. independent and large European companies have shown an interest.

France.—Exploration continued to be concentrated in the Aquitaine region. A total of 13 exploratory wells were drilled in 1972 compared to 12 in 1971, and geophysical activity decreased about 20%. French companies continued to explore for oil in foreign areas at a rapid pace. Regions of major activity include the North Sea, Africa, Canada, and Iran. French companies have also been seeking maritime permits on the Atlantic and Mediterranean Continental Shelves of France. Production of crude oil by French companies outside France averaged about 1.5 million barrels per day in 1972.

Gabon.—The Grondin-Marine field discovered 25 miles offshore in 1971 by Société Elf des Pétroles d'Afrique Equatoriale was scheduled to come into production in early 1973. Production is expected to average about 40,000 barrels per day.

Germany, West.—After many months of negotiation following the 1969 decision by the International Court of Justice in The Hague, which upheld West Germany's claim to the North Sea Continental Shelf, Denmark, the Netherlands, and West Germany agreed to new demarcation lines effective November 7, 1972. The new agreement increased the size of the West German Continental Shelf from about 14,700 square miles to about 21,800 square miles. Most of the newly acquired area, in addition to much of the uncontested West Germany Continental Shelf area, will be explored by the North Sea Consortium, a group comprised of both domestic and foreign companies.

Several companies, including United States, French, and West German interests, plan to construct 30 more caverns for underground storage of 70 million barrels of oil south of Emden to comply with future stockpiling requirements.

Greece.—The Government awarded licenses to two local entrepreneurs to build new refining facilities. One license was for expanding the throughput capacity at the existing refinery at Eleusis (near Athens) by 70,000 barrels per day. The unit is to be completed by 1974. The other license was for a new refinery to be built near Pachi near Megara, also in the Athens area. It will have a capacity of 70,000 barrels per day and is to be completed by the end of 1974. Under a unique arrangement, the Government has the right to 50% of net profits or, in the absence of adequate profit, to $0.40 per ton of crude oil refined.

Greenland.—Oil concession grants were further delayed, and drilling is not expected until 1974. However, the Danish Ministry for Greenland distributed a concession draft to interested concerns in October 1972, and licenses were expected to be issued in 1973. Interest centers on the offshore area west of Greenland, near the promising northeastern Canadian areas, and concessions are to be granted initially in the southern and central zones, up to the 72d parallel.

Guatemala.—After years of unsuccessful search, Guatemala's first discovery well was completed in 1972. The well was drilled in the La Tortugas Valley of Northeastern Guatemala by Recursos del Norte, a subsidiary of Basic Resources International of Canada. It flowed at a rate of 1,300 barrels per day. A second well flowed at 1,840 barrels per day. The company plans two more wells in 1973.

India.—A major policy shift took place in India which affected oil production and exploration. Because of the apparent failure of the Government-operated Oil and Gas Commission to find more oil, it became evident that the continued nearly complete reliance on Soviet technology had to be terminated. India is expected to grant offshore drilling contracts to Western companies covering an area of about 100,000 square miles. Production in 1972 averaged about 155,700 barrels per day, 9% above the 1971 level. The production was shared nearly equally between the States of Assam and Gujarat.

Indonesia.—Annual crude oil production in Indonesia exceeded 1 million barrels per day for the first time in 1972. At yearend production rates were approaching 1.2 million barrels per day. The increase came from two new offshore fields as well as from established onshore fields in Sumatra. Japan, the United States, and Trinidad took the bulk of the increased crude oil exports. It was announced in 1972 that since 1966, when Indonesia adopted the production-sharing contract system, output has doubled, more than $1 billion has been invested by foreign concerns, and about 40 contracts have been signed, mostly by U.S. companies, covering more than 3 million square miles on onshore and offshore areas, and that since 1968, 43 new oil and gas accumulations have been found.

The Petromer Trend group of companies found oil on the Vogelkop Peninsula of West Irian. The well flowed 43° API gravity, low-sulfur crude oil at a rate of 1,680 barrels per day. This was the first discovery in the Vogelkop area since 1954. In addition, initial production offshore Kalimantan (Indonesian Borneo) began in late 1972 when the Attaka oilfield came onstream. When fully developed by late 1973 it is expected to produce 100,000 barrels per day. Two other offshore fields were also producing off Java.

Iran.—In June, the Shah of Iran announced a new long-term relationship between the Government and the large international consortium that operates in Iran. Reportedly, the consortium would turn over the huge Abadan refinery to the National Iranian Oil Co. (NIOC) and in turn build a new refinery on Kharg Island. Also included was the transfer to NIOC of substantial amounts of crude for its own use of distribution. At yearend, a formal agreement covering the new relationship had not been reached.

The only discovery announced during 1972 was made by Bushehr Petroleum Co., owned jointly by Amerada Hess Corp. and NIOC. The discovery well tested at 2,000 to 3,000 barrels per day of 14° API gravity oil on a tract adjoining the Fereidoon field near the center of the Persian Gulf. Lavan Petroleum Co. placed in operation two 100,000-gallon-per-day seawater-desalting plants to improve crude oil recovery from its offshore Sassan field.

Completion of two tanker-loading berths increased the loading capacity at the Kharg Island terminal in November 1972 by 60,000 tons per hour (about 440,000 barrels per hour) and doubled the total capacity of the terminal. One of the new berths can accommodate tankers up to 500,000 deadweight tons and the other 300,000 deadweight tons. With the addition of three large tanks, storage capacity at Kharg Island totaled 14 million barrels.

Important projects undertaken were a 40,000-barrel-per-day refinery at Fars, a 20,000-barrel-per-day refinery on Lavan Island, expansion of the Kermanshah refinery by 15,000 barrels per day, and several large liquefied natural gas (LNG) projects involving Japanese and U.S. partners. In addition, NIOC announced that the capacity of the Tehran refinery would be increased by 100,000 barrels per day to 190,000 barrels per day at a cost of $100 million to meet the increasing demand of central and northern Iran.

Abroad, NIOC agreed to participate in the construction of refineries in Belgium and Greece and to supply crude oil to the 50,000-barrel-per-day refinery at Sasolburg in the Republic of South Africa.

Also, NIOC was to establish a 60,000-barrel-per-day refinery in the Philippines in which it will have a 50% interest and will also provide its crude oil requirements. NIOC already shares in the ownership of two other overseas refineries and has agreed to participate in another.

Iraq.—On June 1 the Iraqi Government nationalized the holdings of Iraq Petroleum Co. (IPC). The company is owned by British, Dutch, French, U.S. and other interests. The affiliates of IPC—Mosul Petroleum Co. Ltd. with a small amount of production in the north and Basrah Petroleum Co. with substantial production in the south—were not affected. Principal among the properties seized were the Kirkuk oilfield (1,117,000 barrels per day in 1971) and the pipelines to the Syrian border which carry crude oil to Mediterranean terminals. At the time of nationalization, the Government promised the French shareholder special terms.

Production from North Rumaila with technical assistance from the U.S.S.R. showed a sharp increase to about 100,000 barrels per day. In late 1972 Soviet officials and the Iraq National Oil Co. (INOC) were considering plans to increase the production to 360,000 barrels per day.

Iraq signed an important service contract agreement with Brazil's state-owned company, Petróleo Brasileiro, S.A. (PETROBRÁS) covering three exploratory blocks totaling 7,900 square kilometers. The agreement called for PETROBRÁS to provide technical and marketing expertise to INOC in return for production offtake privileges.

Ireland.—The U.S. firm Marathon Oil Co. holds leases on nearly three-fourths of Ireland's land area and extensive areas off the south and west coasts. A small number of dry wells have been drilled on land. In July an offshore well tested gas from two formations; however, the discovery failed to confirm a field of commercial size. At yearend Marathon was awaiting government approval to drill its fifth well in the Celtic Sea.

Israel.—Throughput of the Eilat-Ashqelon pipeline during 1972 reached 25.5 million tons (about 510,000 barrels per day), a 31% increase over the 19 million tons carried in 1971. The increase was made possible by the addition of two pump stations, increased storage capacity, and the installation of a fourth loading terminal at Ashqelon. Annual capacity of the line is now 30 million tons and as originally planned should eventually reach 60 million tons per year. Production from Heletz field in 1972 dropped 21% from 1971 to only 47,365 tons and is expected to stop entirely within a year or two. Production from Abu Rudeis and other oilfields on the Sinai Peninsula captured from the Arab Republic of Egypt was reported at 5.25 million tons (about 105,000 barrels per day) in 1972 and was expected to reach 6 million tons in 1973. Reportedly, as much as 3 million tons of Sinai crude oil was exported.

Recent press reports indicate that of the 30 million tons of crude expected to transit the Eilat-Ashqelon pipeline in 1973, about 6 million tons will be destined for use at the Haifa refinery and 1.5 million for the new Ashdod refinery which will begin operating in early 1973.

Italy.—Exploration efforts have been directed offshore in the Adriatic Sea with renewed exploration expected following the 1972 issuance of 21 licenses covering about 1.2 million acres in the Sicilian Channel. A three-well program was planned for drilling beginning during 1972 in water 500 feet deep near the offshore Adriatic Sea boundary with Yugoslavia. At least one company performed seismic surveys in offshore areas of the Tyrrhenian Sea. Most of the country's onshore plans center on natural gas, as crude oil production, all in Sicily, was down to 21,000 barrels per day. The Italian state company, Ente Nazionale Idrocarburi (ENI) continued to work toward strong exploration in foreign regions, especially North Africa and the Middle East.

Jamaica.—The Government reached an agreement in principal with an Italian group in the construction of a new 250,000-barrel-per-day refinery. The plant, like others in the Caribbean area, would serve mainly the United States east coast market.

Japan.—A preliminary agreement was reached between Japan and the Republic of Korea regarding a joint operation in the exploration and development in the offshore Sea of Japan area claimed by both countries. Drilling is expected to commence in the near future.

A strike by Japanese seamen lasted 90 days, the longest in the history of Japan's labor unions. The strike idled 145 tankers totaling 14.5 million deadweight tons and affected the crude oil output of several countries, particularly Abu Dhabi whose principal crude oil exports go to Japan.

With the completion in October of one new refinery and the expansion of nine other plants, Japan's refinery capacity rose by nearly 500,000 barrels per day to a total of 4.7 million barrels per day, the world's third largest after the United States and the U.S.S.R.

The world's largest tanker, the 477,000-deadweight-ton, *Globtik Tokyo* was launched at Hiroshima during October 1972. It is to be completed in early 1973.

Following a favorable report from the Ministry of Health, official permission for petroleum-protein production planning was given. The first two commercial projects will be the 60,000-ton-per-year plant at Gamagori (Shizuoka Prefecture), to be completed in 1974, with provisions for doubling capacity by 1976, and another 60,000-ton-per-year plant at Takasago (Hyogo Prefecture), to be completed in 1973.

Kuwait.—The Government requested the country's major crude oil producing company, Kuwait Oil Co., Ltd. (KOC), owned jointly by British and U.S. firms, to limit oil production to about 2.9 million barrels per day. As the second country, following Libya, to limit production, Kuwait seeks to conserve oil in favor of future higher prices.

Exploration in southwestern Kuwait by KOC resulted in finding a well that tested nearly 2,000 barrels per day. The Spanish company, Hispanica de Petroleos, S. A. (Hispanoil) found oil after drilling two dry wells.

Kuwait Oil Tanker Co., the largest tanker company in the Middle East, purchased two tankers and contracted for a 1973 delivery of a 324,000-deadweight-ton tanker which will bring its total capacity to 1,114,000 deadweight tons.

Libya.—Ente Nacionale Idrocarburi (ENI), the Italian State oil company was finally permitted to export crude from its first Libyan oilfield (Abu Tiffel) after months of negotiations with the Libyan Government. Under the agreement ENI had to forfeit 50% of its ownership of the field to the Government. Reportedly, Libya is to pay ENI for one-half of its cost to find and develop the field. Initial production of 200,000 barrels per day was piped to Zuetina terminal. Production is expected to rise to 300,000 barrels per day.

Less than a week after the agreement with ENI, the Government made a similar demand of Nelson Bunker Hunt's share of the big Sarir field in the Concession 65. In this demand, however, Libya claims half of Hunt's profits from the field, retroactive to December 1971 when the Government seized the half of the field owned by British Petroleum Co., Ltd. (BP).

Malaysia.—Near the end of 1972 the Malaysian Government announced plans to enter production-sharing contracts with oil companies rather than continue the present system of concessions. Present concessions will be respected. Prospects for a substantial oilfield offshore Sabah were encouraging, following the Government announcement that three out of five wells drilled 53 miles northeast of Kota Kinabalu (formerly Jesselton) in the South China Sea have tested at rates of more than 2,000 barrels per day. The concessionaire, an Exxon, Inc., subsidiary, planned to build a fixed drilling platform in the area and rapid development was indicated for Sabah's first oilfield. After 62 years of operation Sarawak Shell Berhad closed its Miri oilfield. It was producing less than 400 barrels per day from 70 of its 624 wells.

Mexico.—Although production increased 4% during 1972, output fell short of sales, which increased 8%. Petróleos Mexicanos (Pemex) had two major discoveries, one offshore and the other onshore, and confirmed the existence of larger quantities of oil than previously estimated in the offshore Arenque field. During the first 8 months of 1972, a total of 278 wells were drilled, of which 165 were productive.

Pemex planned to increase refining capacity by one-third to 930,000 barrels per day in 1976 and to increase pipeline facilities, especially to the interior and from offshore terminal facilities.

Netherlands.—In a third round of exploration license allocations in the Dutch sector of the North Sea, 26 blocks were granted in mid-1972 to 16 companies or groups. Most of the licenses were granted north of the 54th parallel where the new offshore boundary with the West German sector was delineated. All exploration in 1972 resulted in either dry wells or natural gas discoveries. Crude oil output declined 7% to about 30,000 barrels per day.

The country's refining capacity increased a substantial 15% to 1.8 million barrels per day. Plans were to raise this to 2.2 million barrels per day by 1975–76. Included were two of the world's largest refineries, the 540,000-barrel-per-day Pernis plant owned by the Royal Dutch/Shell group of companies and the Rotterdam plant of BP, which will reach 460,000 barrels per day in 1973.

Nigeria.—Major new discoveries announced during the year included the large 18,500-barrel-per-day find 30 miles offshore from Bonny by Occidental Petroleum Corp., in a joint venture with the Nigerian National Oil Corp. The well, which tested 35° API gravity crude from two zones, is the biggest Nigerian discovery. The joint operation of Texaco, Inc., and Chevron Oil Co. made two promising offshore discoveries during the year. The Anyala find 27 miles offshore tested over 5,000 barrels per day from two zones, and the Middleton discovery tested almost 7,000 barrels per day from three zones.

Gulf Oil Corp.'s new Abiteve field, its first onshore field (located 7 miles from the Escravos terminal), came onstream in October and was expected to reach 15,000 barrels per day by yearend.

At yearend total Nigerian production was averaging about 1.9 million barrels per day. The United States and offshore refineries in the Virgin Islands and the Bahamas, were the destination of 27% of Nigeria's crude oil exports. The production growth rate was expected to slow down slightly in 1973 as several small 1970–71 discoveries were expected to come onstream.

Norway.—During the first full year of crude oil production, output averaged about 33,000 barrels per day compared with 5,700 barrels per day in 1971. Production began in June of that year from the offshore Ekofisk field 140 miles west of Stavanger. A giant concrete storage tank (1 million barrels) under construction at Stavanger was scheduled to be moved to the producing area in 1973, and when completed the field should be able to produce 100,000 barrels per day. Phillips Petroleum Co., operator of Ekofisk, concluded an agreement with a U.S. firm for laying a pipeline from Ekofisk field to Teeside on the Yorkshire coast of the United Kingdom at a cost of about $200 million. The contract was subject to final approval by the Storting, Norway's Parliament.

Preliminary estimates place Norway's offshore production potential, based on fields discovered through 1972, at about 1 million barrels per day.

During December 1972 the new Norwegian Government by royal decree stiffened the terms for future offshore exploration agreements by increasing royalties and rentals and by providing for state participation in production without exploration risk.

Oman.—To counter declining production rates, Petroleum Development (Oman), Ltd., launched an exploration program on its onshore agreement area and also placed in operation a water injection program for its Yibal field. The exploration resulted in the discovery of oil in three small structures in the Ghaba area about 60 miles south of the present producing fields.

Peru.—Petróleos del Perú, the state oil company, announced a second discovery in the Amazon basin area of northern Peru. Details of the well were not given, but the first discovery tested 3,000 barrels per day. The location of the new find is remote, and a trans-Andean pipeline will be required to carry the crude to the Pacific coast. However, officials have indicated that a line would be built when reserves are sufficient to sustain a production of 100,000 barrels per day. Earlier, a partnership of two U.S. oil companies discovered oil offshore from Tumbes in the extreme north of Peru. The well yielded a crude having a 39° API gravity from two intervals, one testing more than 1,000 barrels per day.

Philippines.—On September 21, 1972, President Marcos invoked his constitutional powers to assume responsibility for the country's petroleum affairs. This and subsequent legislation made it possible for foreign investors to enter into exploration in the Philippines. The Petroleum Act of 1949 had discouraged foreign investment. As a result of the new legislation, a number of foreign companies responded with proposals following a campaign to encourage exploration by foreign firms. On December 31, 1972, several U.S. petroleum companies and the Philippine Government signed the country's first oil exploration service contract. The area of new interest is off Palawan Island in the Sulu Sea toward Sabah. Exploration on land over many years, carried out by foreign companies in partnership with local interests, has not yielded any commercial oil.

Puerto Rico.—Crown Central Petroleum Corp. announced a project to build a refinery near the port of Guayama which will produce up to 27,000 barrels per day of naphtha and 23,000 barrels per day of fuel oil. It is to be completed in 1975.

Romania.—With production from its older fields on the decline, Romania has entered a stage of diversified research and exploration. Geophysical exploration was being carried out in areas bypassed in the past, secondary recovery methods were being employed in formerly abandoned fields, and the Government has contracted with a U.S. firm to deliver a $3.2 million offshore drilling platform. In addition research was being conducted in the underground combustion of oil shale.

Saudi Arabia.—Saudi Arabia strengthened its position as the world's third largest producer of crude oil. Production rates of about 7 million barrels per day at the close of 1972 suggest that within a few years it may overtake both the U.S.S.R. and the United States. It is expected that production levels will reach 9 million barrels per day by mid-1974.

The expansion program which started in 1971 continued through 1972. Nineteen drilling rigs were in operation at yearend, and despite accelerated production rates, crude oil proved reserves increased by 5 billion barrels, about twice current annual production. Including Saudi Arabia's share of the Kuwait-Saudi Arabia Partitioned Zone, the Government estimated reserves at 157 billion barrels.

Three offshore sea-island tanker loading facilities at Ras Tanura are to be joined by a fourth in early 1973, making the complex the world's largest offshore loading facility. Each of the two berths at the new sea island will have a loading capacity of 280,000 barrels per hour and can handle simultaneously two tankers of from 150,000 to 500,000 deadweight tons. A new loading port is planned for late 1974 which will double the export capacity of the offshore complex to over 10 million barrels per day.

Spain.—The Government approved a variety of offshore and onshore leases during the year, but there was little drilling activity. The several wells drilled were dry.

With surplus refining capacity already available and more anticipated, Spain is in an ideal position to become a major exporter of refined petroleum products. Geographically, the country is located astride major crude oil tanker routes originating in the Mediterranean Sea and the Persian Gulf. Projected refinery surplus is expected to exceed 350,000 barrels per day by 1975.

Syrian Arab Republic.—Immediately following the Iraqi seizure of IPC holdings in Iraq, the Syrian Government nationalized the pipelines that carry crude oil exports from northern Iraq to Mediterranean loading terminals. Exports from Banias, Syria, which fell to a low of 200,000 barrels per day in July, increased rapidly to an average of 744,000 barrels per day in October. At yearend a dispute between Iraq and Syria over transit fees was taking place. Syria was claiming double the fees previously paid by IPC plus a flat annual payment to cover maintenance costs.

Taiwan.—The Government company, Chinese Petroleum Corp. (CPC), continued seismic and gravimetric surveying throughout Taiwan. There were also seismic studies by two companies covering offshore areas. Exploration drilling resulted in one successful oil well, one successful gas well, and four dry wells. Development well drilling resulted in two gas producers and five dry wells.

A U.S. firm concluded a contract with CPC covering the exploration and development of 7 million acres on Taiwan's Continental Shelf in the East China Sea. The triangular area is southwest of, and outside, the area claimed by the Republic of Korea and Japan. It is 110 miles from the Chinese coast, opposite the mouth of the Yangtze River.

Trinidad and Tobago.—Crude oil production continued to decline until August when the offshore Teak (formerly Radix) and Galeota fields came into production. When these two and a third offshore field are brought into full production, it is expected that production will reach 270,000 barrels per day, a national record.

Tunisia.—The two oilfields found in 1971, Sidi el Itayem west of Sfax and the offshore Ashtart field, were put into production at rates of 10,000 and 30,000 barrels per day, respectively. A new field, Sidi Behara with an expected capacity of 12,000 barrels per day, was found 6 miles west of Sidi el Itayem field. The offshore field is being operated from a production platform and a unique mooring buoy which enables tankers to load directly from floating storage tanks. Because of more stringent terms in other North African countries, there has been renewed interest in Tunisian exploration, especially by French and Italian companies. By the end of 1972 much of the onshore area and nearly all of the offshore Continental Shelf was under concession.

Turkey.—Discoveries in 1972 included a field in the Diyarbakir area which was expected to produce 4,000 barrels per day and two others in eastern Turkey which together produced 1,800 barrels per day by yearend. Significantly, two concessions were awarded, one in Western Turkey near Istanbul and the other in the southeast near the Iraqi border. Two U.S. firms announced plans for seismic exploration of nearly 1 million offshore acres in the Marmara Sea from the Bosporus to the Dardanelles. After many years of planning and construction, the Izmir refinery, built with U.S.S.R. assistance, came onstream with a capacity of 66,000 barrels per day.

U.S.S.R.—It was reported at yearend that an agreement in principal was in sight with United States and Japanese interests for the development of some of Siberia's main natural gas resources. The proposed United States-Japanese contribution in development work will count as advance payment for gas shipments to the United States and Japan over 25 years at a combined rate of up to 5 billion cubic feet per day. Involved will be Tyumen and Yakutsk gasfields, and a 1,800-mile, 56-inch pipeline to Murmansk where a liquefaction plant will process Tyumen gas. Yakutsk gas will be shipped via a 2,500-mile, 56-inch pipeline to the Pacific port of Nakhodka. The whole arrangement may involve an expenditure of $50 billion, making it one of the most expensive schemes ever undertaken.

United Arab Emirates.—Production in Abu Dhabi (one of the two emirates having crude production) continued to rise, but because of the Japanese seamen's strike during midyear, the increased rate was lower than those of recent years. An estimated one-third of the production is exported to Japan. Production facilities were being expanded at the onshore fields of Bu Hasa and Asab and the offshore Mubarraz field. With production from the offshore fields of Umm Shaif and Zakum expanded during 1972, it is expected that by 1974–75 total output from Abu Dhabi will reach 2 million barrels daily. A decision on a development scheme for the offshore Bunduq field was pending at yearend.

Negotiations with a West German consortium called Deminex involving the purchase of a share of BP's holdings in Abu Dhabi collapsed. However, at yearend BP was negotiating with a Japanese consortium with other oil interests in Abu Dhabi. In two separate offers, the Government invited bids for offshore exploration areas totaling 6,800 square miles.

Production in Dubai also increased to more than 150,000 barrels per day. Major development was the installation of two large inverted-funnel, bottomless storage tanks to join a similar tank at the offshore Fateh oilfield. Each tank has a 500,000-barrel capacity. A single-buoy mooring capable of handling 300,000-deadweight-ton tankers was also built, making two of that size at Fateh. Dubai production is expected to reach 300,000 barrels per day during 1973.

A promising discovery has been made off the island of Abu Musa in Sharjah waters by Buttes Gas and Oil Co., operator for a group of U.S. companies. The well, in 200 feet of water about 9 miles east of the island, tested 13,955 barrels per day of low-sulfur, 36° API gravity crude oil. Occidental Oil Co., offshore concessionaire for Umm al Quwain, disputes rights in the area and has taken legal action against the group. The dispute stems from action taken by Sharjah in 1970 declaring the width of its territorial waters to be 12 miles instead of 3 miles.

United Kingdom.—Thirty-one exploration wells were drilled in British North Sea waters in 1972, 26 in the northern part and the remainder in the south. In addition 32 development wells were drilled in the British North Sea; all except two were in southern waters. The drilling resulted in several new field finds (Cormorant, Piper, and Beryl), the confirmation of two major fields (Auk and Brent), and the discovery of several natural-gas-condensate fields. Plans are that the large Forties and Auk oilfields will come onstream in 1974 and the Brent field in late 1975.

In March, 246 Fourth Round blocks covering about 23,200 square miles were awarded to 66 companies or combines. During the initial 6 years of these Fourth Round leases, 224 wells are to be drilled west of the Shetland Islands including, for the first time, parts of the Celtic Sea.

Venezuela.—Effective January 1, 1972, tax reference prices were increased an average $0.32 per barrel for crude oil and $0.35 per barrel for refined products. The rising tax-paid cost of Venezuelan crude and declining tanker fees made Middle Eastern crudes more competitive in Venezuela's principal world markets and helped reduce 1972 exports of crude oil. A 9% decline in crude oil production followed. To safeguard its income, the Government applied rules that severely penalize companies for decreasing production below a stipulated amount. In October, the tax reference prices for crude and products applicable to exports in 1973 were officially published effective January 1, 1973. The increases averaged between $0.12 per barrel for crude oil and $0.17 per barrel for refined products. These more recent increases portend future marketing difficulties for Venezuelan petroleum.

Creole Petroleum Corp., a subsidiary of Exxon, Inc., finished a major expansion of its Amuay refinery, raising the capacity to 630,000 barrels per day. Included was an increase from 200,000 to 300,000 barrels per day of desulfurization capacity. Amuay refinery is now the world's largest and represents a total investment of $370 million.

Yugoslavia.—Benicanci, one of the country's most promising fields, came onstream in October 1972. Some 80 wells were drilled in the field through 1972. Production targets are 10,000 barrels per day by the end of 1973. A pipeline was under construction to the Sisak refinery where throughput capacity was increased by 40,000 barrels per day. A second field, Kelebija, which extends across the Hungarian border, began production in early 1972. Stepout wells were drilled at the Velebit oilfield and new gas horizons were discovered at Tilva. In 1975, production from these three and others in the Voivodina is planned at about 20,000 barrels of oil per day and 180 million cubic feet of gas per day.

At yearend, Yugoslavia's lone offshore rig (leased from a French company) was being refitted following the completion of four dry holes off Dugi Otok. Its next assignment will be in the western part of Yugoslavia's Adriatic waters.

Zaire.—In April the Gulf Oil Co. drilled a fourth confirmation well near its 1971 offshore discovery; however, the company was uncertain of the field's promise. Onshore two discoveries were undergoing tests by Gulf to determine if they could be produced commercially. A consortium of foreign oil companies operated by the Belgian firm Petrofina, Inc., found small quantities of oil and gas near the coastal town of Maunda.

Table 2.—Supply, demand, and stocks of all oils in the United States

(Thousand barrels)

Item	1968	1969	1970	1971	1972 p
Domestic production:					
Crude oil	3,169,586	3,203,996	3,350,666	3,296,612	3,293,399
Lease condensate	159,456	167,755	166,784	157,302	161,969
Natural gas plant liquids	550,311	580,241	605,916	617,815	638,216
Imports:					
Crude oil [1]	472,323	514,114	483,293	613,417	811,135
Unfinished oils [1]	29,350	38,766	39,261	45,193	45,705
Plant condensate	---	--	2,258	13,321	31,428
Refined products	537,696	602,671	723,250	760,949	846,988
Other hydrocarbons and hydrogen refinery input	3,377	4,213	6,238	6,074	10,118
Total new supply	4,922,099	5,111,756	5,377,666	5,510,683	5,838,958
Unaccounted for crude oil [2]	+7,138	−2,561	−7,721	+14,823	+10,201
Processing gain	116,691	122,412	131,052	139,433	142,161
Total supply	5,045,928	5,231,607	5,500,997	5,664,939	5,991,320
Change in stocks of all oil	+55,461	−17,449	+37,738	+26,086	−84,968
Total disposition of primary supply	4,990,467	5,249,056	5,463,259	5,638,853	6,076,288
Exports:[3]					
Crude oil	1,802	1,436	4,991	503	187
Refined products	82,742	83,449	89,467	81,342	81,281
Crude losses	4,134	4,241	4,328	4,448	4,641
Domestic demand for products:					
Gasoline:					
Motor gasoline	1,925,376	2,016,995	2,111,349	2,195,267	2,333,777
Aviation gasoline	30,624	25,551	19,903	17,892	16,628
Total gasoline	1,956,000	2,042,546	2,131,252	2,213,159	2,350,405
Jet fuel:					
Naphtha-type	126,601	108,518	90,927	94,732	88,495
Kerosine-type	222,777	253,213	262,051	273,991	293,995
Total jet fuel	349,378	361,731	352,978	368,723	382,490
Ethane (including ethylene)	55,152	72,216	83,757	87,744	106,201
Liquefied gases	330,589	373,410	363,059	369,008	413,649
Kerosine	102,934	100,369	95,974	90,917	85,854
Distillate fuel oil	874,539	900,262	927,211	971,316	1,066,049
Residual fuel oil	668,239	721,924	804,288	838,045	925,647
Petrochemical feedstocks [4]	92,936	94,648	101,183	110,525	123,867
Special naphthas	27,007	29,598	31,390	29,762	31,888
Lubricants	48,467	48,782	49,693	49,321	52,801
Wax	4,360	4,588	4,607	5,248	5,410
Coke	76,319	80,830	77,215	79,897	88,319
Asphalt	141,151	143,290	153,477	158,526	163,788
Road oil	7,080	8,756	9,641	8,487	7,538
Still gas for fuel	149,796	160,363	163,905	156,967	170,993
Miscellaneous products	17,842	16,617	14,843	14,915	15,280
Total domestic demand	4,901,789	5,159,930	5,364,473	5,552,560	5,990,179
Stocks of all oils:					
Crude oil and lease condensate	272,193	265,227	276,367	259,648	246,395
Unfinished oils	93,399	97,819	98,989	100,574	94,761
Natural gasoline and plant condensate [5]	5,466	5,704	7,046	6,176	6,075
Refined products	628,514	611,373	635,459	677,549	611,748
Total	999,572	980,123	1,017,861	1,043,947	958,979

p Preliminary.
[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 data.
[4] Produced at petroleum refineries. Demands for ethane and liquefied gases used for petroleum feedstocks are excluded. Demand data for these products for petrochemical feedstocks use are included under the items "Ethane" and "Liquefied gases."
[5] Includes isopentane.

Table 3.—Supply and demand of all oils in the United States, by month

(Thousand barrels)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1971													
New supply:													
Domestic production:													
Crude petroleum	285,104	259,303	288,790	279,595	285,458	275,261	280,394	279,021	262,279	271,662	261,260	268,485	3,296,612
Lease condensate	14,201	13,101	14,019	13,473	13,522	12,856	12,760	12,709	11,778	12,370	12,910	13,603	157,302
Natural gas plant liquids	52,275	48,170	52,356	50,774	52,330	49,801	51,213	52,265	50,412	52,102	50,659	55,458	617,815
Imports:													
Crude petroleum [1]	34,772	37,655	43,235	45,207	46,540	50,337	54,768	58,755	57,012	59,617	59,557	65,962	613,417
Unfinished oils	3,019	2,591	2,674	3,268	3,020	3,527	4,420	4,686	4,367	4,358	3,884	5,379	45,193
Plant condensate	203	368	514	502	557	1,576	1,594	1,528	1,857	1,638	1,126	1,858	13,321
Refined products	71,664	65,110	72,532	58,623	58,811	57,568	58,981	53,668	57,538	56,312	63,800	86,342	760,949
Other hydrocarbons and hydrogen refinery input	448	343	449	478	430	532	552	443	439	732	563	665	6,074
Total new supply	461,686	426,641	474,569	451,920	460,668	451,458	464,682	463,075	445,682	458,791	453,759	497,752	5,510,683
Crude petroleum unaccounted for [2]	+5,053	+31	+338	+3,287	+974	+1,985	+1,901	+2,048	+1,358	−979	+336	−1,509	+14,823
Processing gain	12,793	10,881	11,252	12,753	9,939	10,655	11,183	12,975	11,792	12,010	10,728	12,472	139,433
Total supply	479,532	437,553	486,159	467,960	471,581	464,098	477,766	478,098	458,832	469,822	464,823	508,715	5,664,939
Change in stocks, all oils [3]	−37,434	−36,587	−9,435	+11,313	+40,247	+17,557	+32,450	+29,699	+17,817	+13,942	−22,226	−31,257	+26,086
Total disposition of primary supply	516,966	474,140	495,594	456,647	431,334	446,541	445,316	448,399	441,015	455,880	487,049	539,972	5,638,853
Exports:[4]													
Crude oil	--	2	1	313	8	--	--	--	143	36	--	--	503
Refined products	6,139	6,731	7,776	8,111	6,978	7,194	5,483	6,681	5,693	5,846	8,069	6,641	81,342
Crude losses	375	342	375	366	363	375	385	382	364	376	364	381	4,448
Domestic demand for products:													
Gasoline:													
Motor gasoline	163,169	153,370	181,002	185,942	182,971	193,550	199,393	195,190	182,050	187,028	183,425	188,177	2,195,267
Aviation gasoline	1,423	1,197	1,607	1,695	1,527	1,527	1,576	1,815	1,576	1,610	1,182	1,157	17,892
Total gasoline	164,592	154,567	182,609	187,637	184,498	195,077	200,969	197,005	183,626	188,638	184,607	189,334	2,213,159
Jet fuel:													
Naphtha type	7,070	7,159	7,650	7,640	7,616	8,102	7,608	8,445	8,726	8,141	8,206	8,369	94,732
Kerosine type	22,248	22,429	23,094	21,097	21,770	23,050	22,843	23,564	21,558	24,078	22,272	25,988	273,991
Total jet fuel	29,318	29,588	30,744	28,737	29,386	31,152	30,451	32,009	30,284	32,219	30,478	34,357	368,723
Ethane (including ethylene)	6,975	6,536	6,855	6,865	7,153	7,362	7,567	7,738	7,373	7,568	7,635	8,117	87,744
Liquefied gases:													
LRG [5] for fuel use	7,791	7,575	7,545	6,980	6,449	6,986	7,527	7,588	6,270	7,118	6,956	8,304	87,089
LRG [5] for chemical use	2,247	2,351	2,663	2,684	2,659	2,792	2,998	2,676	2,595	2,781	2,869	2,837	32,152
LPG [6] for fuel and chemical use	34,560	27,267	21,152	14,800	12,900	12,174	11,480	15,459	18,800	21,917	26,743	32,515	249,767
Total liquefied gases	44,598	37,193	31,360	24,464	22,008	21,952	22,005	25,723	27,665	31,816	36,568	43,656	369,008
Kerosine	13,366	12,671	8,761	6,339	3,876	4,520	4,378	4,475	5,868	6,800	8,536	11,327	90,917
Distillate fuel oil	123,725	107,336	99,135	79,050	65,692	60,093	54,376	56,100	61,164	65,610	85,436	113,599	971,316
Residual fuel oil	86,464	80,728	82,564	66,857	60,022	59,504	59,590	55,732	62,177	59,835	77,162	87,410	838,045

See footnotes at end of table.

Table 3.—Supply and demand of all oils in the United States, by month—Continued

(Thousand barrels)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Domestic demand for products—Continued													
Petrochemical feedstocks:[7]													
Still gas	1,135	1,575	1,242	1,433	1,131	1,372	1,509	1,966	1,688	1,158	984	965	16,158
Naphtha—400°	5,005	4,313	5,069	4,673	4,713	4,912	4,191	4,930	4,805	5,003	4,277	4,930	56,821
Other	2,237	2,324	2,184	3,173	3,469	2,780	3,452	2,839	3,698	3,550	3,665	4,175	37,546
Total petrochemical feedstocks	8,377	8,212	8,495	9,279	9,313	9,064	9,152	9,735	10,191	9,711	8,926	10,070	110,525
Special naphthas	2,387	2,384	2,946	2,150	2,502	2,382	2,495	2,269	2,693	2,533	2,407	2,614	29,762
Lubricants	3,574	3,668	4,125	4,432	3,985	4,777	4,571	4,347	3,610	4,564	3,811	3,857	49,321
Wax	315	390	517	456	455	473	348	478	483	420	514	399	5,248
Coke	6,660	6,147	6,629	6,824	5,979	6,743	7,288	7,332	5,558	7,986	6,157	6,594	79,897
Asphalt	4,829	4,862	8,083	10,363	14,045	19,904	19,440	21,884	19,283	17,159	12,246	6,428	158,526
Road oil	122	81	146	300	692	1,268	1,479	1,693	1,174	777	499	256	8,487
Still gas	13,616	11,433	13,129	12,664	13,326	13,505	14,002	13,639	12,748	12,860	12,464	13,581	156,967
Miscellaneous products	1,534	1,269	1,344	1,440	1,053	1,196	1,337	1,177	918	1,126	1,170	1,351	14,915
Total domestic demand	510,452	467,065	487,442	447,857	423,985	438,972	439,448	441,336	434,815	449,622	478,616	532,950	5,552,560
Stocks all oils:													
Crude oil and lease condensate	269,806	266,864	267,246	271,445	284,320	279,337	273,235	272,417	269,771	265,899	265,552	259,648	259,648
Unfinished oils	94,379	90,562	90,492	98,636	100,648	102,891	103,625	100,322	99,378	103,355	103,921	100,574	100,574
Natural gasoline and plant condensate[8]	6,805	6,609	6,258	6,791	6,869	6,585	6,755	6,668	6,527	6,442	6,340	6,176	6,176
Refined products	609,437	579,805	570,409	568,846	594,128	614,709	652,357	686,264	707,812	721,734	699,391	677,549	677,549
Total	980,427	943,840	934,405	945,718	985,965	1,003,522	1,035,972	1,065,671	1,083,488	1,097,430	1,075,204	1,043,947	1,043,947
1972 p													
New supply:													
Domestic production:													
Crude petroleum	268,442	257,325	279,358	272,039	284,217	272,573	281,082	280,685	272,575	280,491	269,079	275,533	3,293,399
Lease condensate	14,101	13,424	13,953	13,350	13,826	13,073	13,303	13,273	12,674	13,438	13,714	13,840	161,969
Natural gas plant liquids	52,840	50,649	54,814	53,073	53,842	52,028	53,668	53,896	52,533	54,825	52,710	53,338	638,216
Imports:													
Crude petroleum[1]	63,419	60,344	64,066	60,129	66,958	62,544	67,635	65,463	70,909	78,003	68,978	82,687	811,135
Unfinished oils	5,520	4,189	3,234	3,542	2,495	3,011	3,339	3,600	3,956	4,214	3,846	4,759	45,705
Plant condensate	1,748	1,758	2,196	1,782	2,701	2,414	2,770	3,309	3,039	2,963	3,365	3,383	31,428
Refined products	77,116	74,218	79,020	63,616	63,244	66,035	62,651	65,748	63,269	73,636	72,257	86,178	846,988
Other hydrocarbons and hydrogen refinery input	578	614	883	808	732	808	862	1,012	757	1,006	1,167	891	10,118
Total new supply	483,764	462,521	497,524	468,339	488,015	472,486	485,310	486,986	479,712	508,576	485,116	520,609	5,838,958
Crude petroleum unaccounted for[2]	−831	+853	+963	−1,387	+4,381	−315	+1,645	+2,852	+793	−214	+2,130	−669	+10,201
Processing gain	11,501	9,828	11,808	10,977	10,807	10,112	11,199	13,826	12,285	13,817	12,043	13,958	142,161
Total supply	494,434	473,202	510,295	477,929	503,203	482,283	498,154	503,664	492,790	522,179	499,289	533,898	5,991,320
Change in stocks, all oils[3]	−30,013	−49,831	−21,803	+4,334	+37,799	+7,199	+31,766	+1,909	+20,881	+4,434	−36,703	−54,940	−84,968
Total disposition of primary supply	524,447	523,033	532,098	473,595	465,404	475,084	466,388	501,755	471,909	517,745	535,992	588,838	6,076,288
Exports:[4]													
Crude oil	--	--	--	187	--	--	--	--	--	--	--	--	187
Refined products	5,245	4,741	8,998	7,173	6,176	6,309	6,384	7,175	6,894	7,286	7,430	7,470	81,281
Crude losses	383	359	382	366	386	385	399	399	393	398	386	405	4,641

Domestic demand for products:													
Gasoline:													
Motor gasoline	172,012	165,591	198,760	188,502	199,792	204,660	206,858	215,088	193,574	196,849	194,363	197,728	2,333,777
Aviation gasoline	1,186	1,270	1,634	1,458	1,379	1,449	1,485	1,499	1,351	1,676	1,135	1,106	16,628
Total gasoline	173,198	166,861	200,394	189,960	201,171	206,109	208,343	216,587	194,925	198,525	195,498	198,834	2,350,405
Jet fuel:													
Naphtha type	6,765	7,507	6,581	7,944	8,229	7,998	7,159	6,835	7,079	7,934	7,846	6,618	88,495
Kerosine type	24,871	25,584	24,664	21,619	22,755	26,901	23,828	22,497	23,958	28,375	23,643	25,300	293,995
Total jet fuel	31,636	33,091	31,245	29,563	30,984	34,899	30,987	29,332	31,037	36,309	31,489	31,918	382,490
Ethane (including ethylene)	8,387	8,200	9,019	8,111	8,473	8,377	9,196	9,246	9,060	9,787	8,889	9,456	106,201
Liquefied gases:													
LRG[5] for fuel use	7,501	7,575	6,680	5,935	6,197	6,968	6,548	6,796	6,674	6,979	7,554	8,612	84,019
LRG[5] for chemical use	2,988	2,831	3,013	2,994	3,356	3,227	3,284	3,173	2,867	2,939	2,796	3,275	36,743
LPG[6] for fuel and chemical use	35,251	32,199	25,199	18,395	12,847	14,871	15,709	19,339	18,721	27,578	33,796	38,982	292,887
Total liquefied gases	45,740	42,605	34,892	27,324	22,400	25,066	25,541	29,308	28,262	37,496	44,146	50,869	413,649
Kerosine	11,817	10,703	8,769	5,266	4,432	3,475	2,861	5,295	5,945	7,366	8,553	11,372	85,854
Distillate fuel oil	115,432	120,758	107,760	83,333	69,765	65,815	54,829	63,982	66,157	85,534	101,500	131,184	1,066,049
Residual fuel oil	87,275	91,953	83,151	73,311	65,439	65,873	65,375	70,068	67,112	73,162	85,284	97,644	925,647
Petrochemical feedstocks:[7]													
Still gas	1,230	1,055	1,033	935	1,095	1,147	1,378	1,444	1,144	1,500	1,360	1,357	14,678
Naphtha—400°	5,148	4,562	4,393	5,012	4,798	4,874	4,803	4,894	4,419	4,782	4,777	5,613	58,075
Other	3,619	3,801	4,283	4,154	4,615	3,361	4,150	4,517	4,943	5,364	3,807	4,500	51,114
Total petrochemical feedstocks	9,997	9,418	9,709	10,101	10,508	9,382	10,331	10,855	10,506	11,646	9,944	11,470	123,867
Special naphthas	2,503	2,457	3,197	2,398	2,691	2,812	2,423	2,946	2,629	2,915	2,256	2,661	31,888
Lubricants	3,751	4,127	4,575	4,567	4,547	4,299	4,848	4,743	4,286	4,612	4,589	3,857	52,801
Wax	404	422	398	426	462	483	424	504	477	467	490	453	5,410
Coke	7,819	7,211	6,908	6,456	6,458	6,141	6,780	8,424	7,566	8,078	8,268	8,210	88,319
Asphalt	5,691	6,096	7,547	10,110	15,680	19,222	20,014	24,244	19,727	17,556	11,139	6,762	163,788
Road oil	167	86	174	335	848	1,047	1,347	1,334	1,039	771	287	103	7,538
Still gas	13,814	12,700	13,514	13,375	13,977	14,381	15,171	15,589	14,642	14,573	14,308	14,949	170,993
Miscellaneous products	1,188	1,245	1,466	1,233	1,007	1,009	1,135	1,724	1,252	1,264	1,536	1,221	15,280
Total domestic demand	518,819	517,933	522,718	465,869	458,842	468,390	459,605	494,181	464,622	510,061	528,176	580,963	5,990,179
Stocks all oils:													
Crude oil and lease condensate	251,012	252,945	258,902	266,636	279,490	271,381	265,843	257,976	250,802	253,748	251,306	246,395	246,395
Unfinished oils	102,763	99,110	103,137	106,890	109,535	114,054	109,574	104,871	106,043	103,482	101,221	94,761	94,761
Natural gasoline and plant condensate[8]	6,395	6,543	6,633	6,737	6,766	6,392	6,416	7,019	7,023	6,740	6,295	6,075	6,075
Refined products	653,764	605,505	573,628	566,371	588,642	599,805	641,565	655,441	682,320	686,652	655,097	611,748	611,748
Total	1,013,934	964,103	942,300	946,634	984,433	991,632	1,023,398	1,025,307	1,046,188	1,050,622	1,013,919	958,979	958,979

[p] Preliminary.
[1] U.S. Department of the Interior data for crude oil, unfinished oils, and plant condensate; U.S. Department of Commerce data for all other imports.
[2] Represents the difference between supply and indicated demand for crude petroleum.
[3] Minus represents withdrawal from stock, which is added to total disposition; plus represents stocks increase, which is subtracted from total disposition.
[4] U.S. Department of Commerce data.
[5] Liquefied refinery gas.
[6] Liquefied petroleum gas.
[7] Produced at petroleum refineries. Data for LPG for petrochemical feedstocks are included with those for "Liquefied gases."
[8] Includes isopentane.

Table 4.—Estimates of proved crude-oil reserves in the United States on December 31, by State[1]

(Million barrels)

State	1968	1969	1970	1971	1972
Eastern States:					
Illinois	314	272	229	209	175
Indiana	40	41	37	31	29
Kentucky	80	73	61	52	48
Michigan	55	52	46	59	62
New York	13	12	11	10	9
Ohio	132	127	128	129	127
Pennsylvania	59	55	51	47	37
West Virginia	54	53	53	52	34
Total	747	685	616	589	521
Central and Southern States:					
Alabama	73	67	65	61	57
Arkansas	159	127	130	118	113
Florida	(2)	(2)	(2)	204	208
Kansas	601	566	539	502	453
Louisiana[3]	5,608	5,689	5,710	5,399	5,029
Mississippi	326	360	355	342	313
Nebraska	55	47	41	36	31
New Mexico	865	840	761	657	583
North Dakota	287	235	192	174	166
Oklahoma	1,395	1,390	1,351	1,405	1,303
Texas[3]	13,810	13,063	13,195	13,023	12,144
Total	23,179	22,384	22,339	r 21,921	20,400
Mountain States:					
Colorado	420	401	389	333	326
Montana	345	276	242	228	241
Utah	180	195	182	166	244
Wyoming	1,101	997	1,017	997	950
Total	2,046	1,869	1,830	1,724	1,761
Pacific Coast States:					
Alaska	373	432	10,149	10,116	[4] 10,096
California[3]	4,341	4,243	3,984	3,706	3,554
Total[1]	4,714	4,675	14,133	13,822	13,650
Other States[5]	21	19	83	7	7
Total United States	30,707	29,632	39,001	38,063	36,339

r Revised.

1 From reports of Committee of Petroleum Reserves, American Petroleum Institute. Includes crude oil that may be extracted by present methods from fields completely developed or sufficiently explored to permit reasonable accurate calculations. The change in reserves during any year represents total new discoveries, extensions, and revisions, minus production.

2 Included with "Other States."

3 Includes offshore reserves.

4 This number includes the estimate of proved reserves in the Prudhoe Bay Permo-Triassic reservoir, discovered in 1968. This estimate is based on the analysis of extensive engineering and geologic data; however, revisions may be required when actual production performance becomes available.

5 Includes Arizona, Missouri, Nevada, South Dakota, Tennessee, and Virginia.

Table 5.—Supply and disposition of crude petroleum (including lease condensate) in the United States

(Thousand barrels)

Supply and disposition	1968	1969	1970	1971	1972 p
Supply:					
Production	3,329,042	3,371,751	3,517,450	3,453,914	3,455,368
Imports[1]	472,323	514,114	483,293	613,417	811,135
Total new supply	3,801,365	3,885,865	4,000,743	4,067,331	4,266,503
Stock changes:[2]					
Domestic crude	+17,653	−4,668	+10,380	−23,239	−17,064
Foreign crude	+5,570	−2,298	+760	+6,520	+3,811
Unaccounted for[3]	+7,138	−2,561	−7,721	+14,823	+10,201
Disposition by use:					
Runs of domestic crude	3,308,044	3,363,602	3,485,332	3,481,543	3,473,880
Runs of foreign crude	466,316	516,003	482,171	606,266	806,983
Exports[4]	1,802	1,436	4,991	503	187
Transfers:					
Distillate	712	654	743	1,548	944
Residual	4,272	4,334	4,317	4,565	3,322
Losses	4,134	4,241	4,328	4,448	4,641
Total disposition by use	3,785,280	3,890,270	3,981,882	4,098,873	4,289,957

p Preliminary except for crude petroleum production.

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 beginning with 1968.

4 U.S. Department of Commerce data.

Table 6.—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
1971													
Supply:													
Production	299,305	272,404	302,809	293,068	298,980	288,117	293,154	291,730	274,057	284,032	274,170	282,088	3,453,914
Imports [1]	34,772	37,655	43,235	45,207	46,540	50,337	54,768	58,755	57,012	59,617	59,557	65,962	613,417
Total new supply	334,077	310,059	346,044	338,275	345,520	338,454	347,922	350,485	331,069	343,649	333,727	348,050	4,067,331
Change in stocks, end of period:													
Domestic crude	−1,987	−4,707	−1,837	+2,420	+11,545	−4,597	−8,530	−1,631	−1,869	−6,366	+2,865	−8,545	−23,239
Foreign crude	−4,574	+1,765	+2,219	+1,779	+1,330	−386	+2,428	+813	−777	+2,494	−3,212	+2,641	+6,520
Unaccounted for [2]	+5,053	+31	+338	+3,287	+974	+1,985	+1,901	+2,048	+1,358	−979	+336	−1,509	+14,823
Disposition by use:													
Runs of domestic crude	305,620	276,397	304,104	292,953	287,682	293,854	302,703	294,498	276,284	288,419	270,829	288,200	3,481,543
Runs of foreign crude	39,316	35,869	40,974	43,269	45,117	50,651	52,304	57,907	57,750	57,097	62,732	63,280	606,266
Exports [3]	--	2	1	313	8	--	--	--	143	36	--	--	503
Transfers:													
Distillate	52	51	67	125	124	166	166	184	159	142	131	181	1,548
Residual	328	371	479	337	325	376	367	380	373	472	354	403	4,565
Losses	375	342	375	366	363	375	385	382	364	376	364	381	4,448
Total disposition by use	345,691	313,032	346,000	337,363	333,619	345,422	355,925	353,351	335,073	346,542	334,410	352,445	4,098,873
1972 p													
Supply:													
Production	282,543	270,749	293,311	285,389	298,043	285,646	294,385	293,958	285,249	293,929	282,793	289,373	3,455,368
Imports [1]	63,419	60,344	64,066	60,129	66,958	62,544	67,635	65,463	70,909	78,003	68,978	82,687	811,135
Total new supply	345,962	331,093	357,377	345,518	365,001	348,190	362,020	359,421	356,158	371,932	351,771	372,060	4,266,503
Change in stocks, end of period:													
Domestic crude	−7,727	+2,899	+5,379	+4,948	+8,886	−4,812	−8,055	−7,108	−4,248	+1,102	+1,408	−9,736	−17,064
Foreign crude	−909	−966	+578	+2,786	+3,968	−3,297	+2,517	−759	−2,926	+1,844	−3,850	+4,825	+3,811
Unaccounted for [2]	−831	+853	+963	−1,387	+4,381	−315	+1,645	+2,852	+793	−214	+2,130	−669	+10,201
Disposition by use:													
Runs of domestic crude	288,758	268,078	288,230	278,197	292,840	289,416	303,350	303,162	289,560	291,916	282,723	297,650	3,473,880
Runs of foreign crude	64,277	61,254	63,473	57,336	62,966	65,820	65,095	66,215	73,804	76,083	72,815	77,845	806,983
Exports [3]	--	--	--	187	--	--	--	--	--	--	--	--	187
Transfers:													
Distillate	72	60	46	68	81	88	91	92	89	66	105	86	944
Residual	277	262	252	243	255	275	268	272	279	309	314	316	3,322
Losses	383	359	382	366	386	385	399	399	393	398	386	405	4,641
Total disposition by use	353,767	330,013	352,383	336,397	356,528	355,984	369,203	370,140	364,125	368,772	356,343	376,302	4,289,957

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 7.—Production of crude petroleum (including lease condensate) in the United States, by State and month

(Thousand barrels)

State	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1971													
Alabama	628	601	658	646	663	638	659	661	653	663	674	688	7,832
Alaska	6,174	5,904	6,481	6,467	7,177	6,831	7,121	6,923	6,613	6,837	6,529	6,437	79,494
Arizona	123	106	120	108	110	103	106	103	93	83	90	91	1,236
Arkansas	1,568	1,395	1,586	1,551	1,561	1,511	1,513	1,528	1,423	1,551	1,511	1,565	18,263
California:													
South	12,456	11,113	12,332	11,940	12,251	11,867	12,146	12,017	11,546	11,923	11,478	11,836	142,905
Central Coastal	7,308	6,539	7,320	7,218	7,508	7,317	7,391	7,359	7,086	7,183	6,865	6,884	85,978
East Central	10,927	10,000	11,436	10,722	11,023	10,613	10,898	10,841	10,524	10,774	10,543	10,648	128,949
North	53	53	53	56	57	57	54	54	48	50	57	60	652
Total California	30,744	27,705	31,141	29,936	30,839	29,854	30,489	30,271	29,204	29,930	28,943	29,428	358,484
Colorado	2,094	1,950	2,242	2,311	2,062	1,784	3,107	2,362	2,196	2,275	2,580	2,428	27,391
Florida	433	399	479	506	434	406	438	434	430	439	451	498	5,347
Illinois	3,383	3,104	3,538	3,322	3,323	3,305	3,262	3,285	3,091	3,210	3,114	3,147	39,084
Indiana	552	495	592	560	560	563	563	570	543	543	552	565	6,658
Kansas	6,532	5,676	7,135	6,711	6,627	6,680	6,636	6,680	6,425	6,486	6,386	6,558	78,532
Kentucky	875	817	958	917	905	903	890	911	867	857	878	914	10,692
Louisiana:													
Gulf Coast	75,882	70,052	76,387	75,023	77,245	74,957	76,668	78,014	69,108	73,788	70,214	72,490	889,828
Rest of State	3,957	3,580	3,884	3,794	3,895	3,793	3,858	3,817	3,677	3,778	3,641	3,741	45,415
Total Louisiana	79,839	73,632	80,271	78,817	81,140	78,750	80,526	81,831	72,785	77,566	73,855	76,231	935,243
Michigan	937	881	995	976	1,033	987	984	996	1,009	1,014	1,019	1,062	11,893
Mississippi	5,539	5,057	5,647	5,542	5,576	5,313	5,410	5,444	5,222	5,222	4,964	5,130	64,066
Missouri	6	5	6	5	6	5	6	5	5	6	5	6	66
Montana	3,107	2,762	3,058	2,880	2,912	2,892	2,889	2,893	2,807	2,826	2,746	2,827	34,599
Nebraska	925	834	886	854	857	814	822	814	788	818	808	842	10,062
Nevada	7	9	12	10	11	10	8	9	9	9	10	9	113
New Mexico:													
Southeastern	9,611	8,793	9,693	9,331	9,564	9,148	9,162	9,095	8,439	9,269	8,657	8,835	109,597
Northwestern	760	728	801	738	749	714	919	904	523	394	780	805	8,815
Total New Mexico	10,371	9,521	10,494	10,069	10,313	9,862	10,081	9,999	8,962	9,663	9,437	9,640	118,412
New York	98	86	99	85	103	99	101	86	100	97	92	80	1,126
North Dakota	1,823	1,658	1,862	1,788	1,859	1,784	1,853	1,840	1,791	1,834	1,756	1,805	21,653
Ohio	753	594	750	707	656	700	654	623	689	783	679	698	8,286
Oklahoma	18,031	16,048	18,695	17,967	18,146	17,785	18,099	18,271	17,409	17,586	17,186	18,090	213,313
Pennsylvania	292	269	330	319	318	339	326	327	331	322	316	309	3,798
South Dakota	12	11	20	25	25	21	22	17	20	19	22	19	233
Tennessee	34	30	34	33	34	33	34	34	32	34	32	34	398

Texas:													
District 1	1,738	1,648	1,871	1,835	1,948	1,924	1,985	1,879	1,913	1,962	1,891	1,997	22,591
District 2	7,162	6,446	7,035	6,888	6,913	6,420	6,262	6,106	5,778	5,885	5,689	5,844	76,428
District 3	15,022	13,502	15,013	14,492	14,622	13,825	13,531	13,016	12,334	12,593	12,054	12,365	162,369
District 4	7,313	6,565	7,072	6,748	6,733	6,361	6,412	6,287	5,838	6,068	5,923	6,029	77,349
District 5	2,436	2,219	2,455	2,448	2,427	2,301	2,231	2,159	2,048	2,088	2,026	2,082	26,920
District 6, except East Texas	6,947	6,218	6,958	6,641	6,619	6,341	6,027	5,921	5,730	5,723	5,463	5,661	74,249
East Texas	6,581	5,897	6,552	6,224	6,131	5,787	5,444	5,264	5,027	5,079	4,851	5,023	67,860
District 7B	3,258	2,930	3,270	3,163	3,162	3,038	3,033	2,992	2,898	2,950	2,884	2,912	36,490
District 7C	3,835	3,541	3,898	3,702	3,722	3,526	3,520	3,544	3,400	3,521	3,437	3,554	43,200
District 8	25,180	22,933	25,433	24,382	24,866	23,907	24,212	24,179	23,345	24,162	23,323	24,036	289,958
District 8A	23,227	21,068	23,247	22,400	23,198	22,160	22,725	22,415	21,366	22,081	21,321	22,298	267,506
District 9	4,637	4,208	4,655	4,467	4,517	4,228	4,290	4,284	4,073	4,234	4,121	4,141	51,855
District 10	2,260	1,968	2,339	2,243	2,294	2,166	2,170	2,183	2,135	2,143	2,102	2,148	26,151
Total Texas	109,596	99,143	109,798	105,633	107,152	101,984	101,842	100,229	95,885	98,489	95,085	98,090	1,222,926
Utah	1,898	1,764	1,967	1,858	1,897	1,872	1,952	2,082	2,081	2,112	2,010	2,137	23,630
Virginia	--	--	--	--	--	--	--	--	--	--	--	1	1
West Virginia	235	208	265	252	263	260	245	259	257	244	226	255	2,969
Wyoming	12,696	11,740	12,690	12,213	12,418	12,029	12,516	12,243	12,337	12,514	12,214	12,504	148,114
Total United States:													
1971	299,305	272,404	302,809	293,068	298,980	288,117	293,154	291,730	274,057	284,032	274,170	282,088	3,453,914
1970	293,832	267,964	294,741	287,737	295,217	280,765	285,227	296,366	295,593	310,410	301,331	308,267	3,517,450
Daily average, 1971	9,655.0	9,728.7	9,768.0	9,768.9	9,644.5	9,603.9	9,456.6	9,410.6	9,135.2	9,162.3	9,139.0	9,099.6	9,462.8
Pennsylvania grade (included in U.S. total)	946	866	1,066	1,024	1,029	1,056	1,012	1,017	1,119	1,105	1,067	1,091	12,398
1972													
Alabama	730	697	782	784	838	818	892	907	879	882	857	868	9,934
Alaska	6,423	5,448	6,261	6,066	6,228	6,085	6,276	6,059	5,883	6,124	5,946	6,094	72,893
Arizona	89	83	87	80	86	83	87	89	86	79	64	80	993
Arkansas	1,521	1,463	1,570	1,523	1,582	1,531	1,584	1,577	1,526	1,588	1,501	1,553	18,519
California:													
South	11,879	11,377	11,901	11,549	12,153	11,725	12,101	12,128	11,642	11,972	11,639	11,817	141,883
Central Coastal	6,736	6,192	6,683	6,392	6,560	6,307	6,547	6,538	6,285	6,477	6,233	6,383	77,333
East Central	10,730	10,140	10,884	10,601	10,866	10,386	10,719	10,755	10,413	10,805	10,346	10,494	127,139
North	53	50	47	50	58	53	54	58	48	61	68	67	667
Total California	29,398	27,759	29,515	28,592	29,637	28,471	29,421	29,479	28,388	29,315	28,286	28,761	347,022
Colorado	2,239	2,215	2,445	2,390	2,587	2,523	2,641	2,760	2,868	2,866	3,158	3,323	32,015
Florida	532	554	621	958	1,178	1,126	1,497	1,774	1,954	1,922	2,201	2,580	16,897
Illinois	3,198	2,874	3,071	2,828	3,044	2,912	2,859	2,976	2,769	2,869	2,798	2,676	34,874
Indiana	614	483	525	471	522	495	503	544	512	534	482	445	6,130
Kansas	6,204	6,159	6,594	6,196	6,513	6,183	6,154	6,272	5,980	6,078	5,702	5,709	73,744
Kentucky	820	794	855	778	869	826	809	846	772	812	779	742	9,702
Louisiana:													
Gulf Coast	71,981	66,427	72,100	69,556	73,360	71,459	71,789	71,592	68,402	71,532	68,868	70,488	847,554
Rest of State	4,041	3,870	4,119	3,959	3,771	1,922	3,600	3,843	4,598	3,799	3,494	3,257	44,273
Total Louisiana	76,022	70,297	76,219	73,515	77,131	73,381	75,389	75,435	73,000	75,331	72,362	73,745	891,827

Table 7.—Production of crude petroleum (including lease condensate) in the United States, by State and month—Continued

(Thousand barrels)

State	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Michigan	1,055	917	994	1,021	1,077	1,076	1,121	1,175	1,158	1,218	1,098	1,080	12,990
Mississippi	5,017	4,760	5,195	5,166	5,306	5,108	5,251	5,233	4,964	5,083	4,895	5,122	61,100
Missouri	5	5	5	5	5	5	5	5	5	5	5	5	60
Montana	2,729	2,624	2,888	2,823	2,906	2,819	2,900	2,855	2,775	2,891	2,798	2,896	33,904
Nebraska	794	743	776	755	763	722	724	719	686	710	662	651	8,705
Nevada	8	8	9	7	9	8	6	7	9	10	8	11	100
New Mexico:													
Southeastern	8,847	8,307	8,836	8,595	8,787	8,339	8,594	8,571	8,172	8,488	8,146	8,238	101,920
Northwestern	817	761	763	749	739	649	693	715	687	691	669	672	8,605
Total New Mexico	9,664	9,068	9,599	9,344	9,526	8,988	9,287	9,286	8,859	9,179	8,815	8,910	110,525
New York	96	88	92	66	90	93	108	72	81	85	74	73	1,018
North Dakota	1,754	1,654	1,791	1,693	1,728	1,698	1,730	1,722	1,696	1,737	1,685	1,736	20,624
Ohio	870	808	805	709	788	799	785	866	721	755	721	731	9,358
Oklahoma	17,696	18,017	17,464	16,921	18,073	17,112	17,967	16,708	17,108	17,165	16,480	16,922	207,633
Pennsylvania	289	266	262	260	304	289	283	302	279	325	294	288	3,441
South Dakota	14	13	23	20	20	18	17	20	18	20	17	19	219
Tennessee	17	15	17	16	17	16	17	17	16	17	16	17	198
Texas:													
District 1	2,032	1,993	2,175	2,122	2,155	2,073	2,116	2,060	1,932	2,015	1,896	1,926	24,495
District 2	5,972	6,028	6,893	7,151	7,338	7,131	7,260	7,011	6,716	6,952	6,661	6,692	81,805
District 3	12,655	12,709	14,560	15,233	15,697	15,100	15,603	15,932	15,433	15,679	14,934	15,267	178,802
District 4	5,977	5,625	6,174	5,953	6,010	5,701	5,740	5,588	5,302	5,471	5,222	5,352	68,115
District 5	2,243	2,334	2,682	2,905	2,991	2,871	2,937	2,940	2,827	2,917	2,818	2,892	33,357
District 6, except East Texas	5,839	5,989	6,893	7,268	7,662	7,341	7,520	7,426	7,171	7,533	7,170	7,280	85,092
East Texas	5,186	5,395	6,375	6,133	6,311	6,083	6,261	6,210	5,988	6,176	5,971	6,105	72,194
District 7B	2,913	2,850	3,132	3,097	3,293	3,211	3,324	3,334	3,202	3,274	3,153	3,212	37,995
District 7C	3,504	3,371	3,650	3,507	3,624	3,447	3,555	3,452	3,382	3,508	3,491	3,589	42,080
District 8	23,909	23,159	24,873	24,321	25,122	23,977	24,801	24,656	23,797	24,451	23,707	24,101	290,874
District 8A	23,095	22,877	25,478	24,688	26,353	25,535	26,708	27,368	26,731	28,146	27,213	28,528	312,720
District 9	4,168	4,005	4,343	4,208	4,366	4,146	4,232	4,137	3,997	4,090	3,966	4,053	49,711
District 10	2,148	2,042	2,194	2,102	2,149	2,043	2,060	2,038	1,966	2,007	1,868	1,828	24,445
Total Texas	99,641	98,377	109,422	108,688	113,071	108,659	112,117	112,152	108,444	112,219	108,070	110,825	1,301,685

Utah	2,196	2,115	2,282	2,204	2,147	2,238	2,193	2,282	2,275	2,281	2,282	2,075	26,570
Virginia	--	--	--	--	--	--	--	--	--	--	--	--	--
West Virginia	222	209	243	219	229	240	220	237	215	224	214	205	2,677
Wyoming	12,686	12,236	12,899	11,291	11,769	11,324	11,542	11,582	11,323	11,605	10,523	11,231	140,011
Total United States:													
1972	282,543	270,749	293,311	285,389	298,043	285,646	294,385	293,958	285,249	293,929	282,793	289,373	3,455,368
1971	299,305	272,404	302,809	293,068	298,980	288,117	293,154	291,730	274,057	284,032	274,170	282,088	3,453,914
Daily average, 1972	9,114	9,336	9,462	9,513	9,614	9,522	9,496	9,483	9,508	9,482	9,426	9,335	9,441
Pennsylvania grade (included in U.S. total)	1,232	1,155	1,121	1,013	1,120	1,127	1,108	1,146	1,016	1,097	1,016	1,025	13,176

Sources of 1972 data:

Alabama—State Oil and Gas Board of Alabama.
Alaska—Alaska Department of Natural Resources.
Arizona—Arizona Oil and Gas Conservation Commission.
Arkansas—Arkansas Oil and Gas Commission.
California—Division of Oil and Gas, California Department of Conservation.
Colorado—Colorado Oil and 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—Geological Survey Division, Michigan Department of Natural Resources.
Mississippi—Mississippi State Oil and Gas Board.
Missouri—Missouri Geological Survey and Water Resources.
Montana—Montana Board of Oil and Gas Conservation.
Nebraska—Nebraska Oil and Gas Conservation Commission.
Nevada—Nevada Oil and Gas Conservation Commission.
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—Topographic and Geologic Survey, Pennsylvania Department of Environmental Resources.
South Dakota—South Dakota Geological Survey.
Tennessee—Division of Geology, Tennessee Department of Conservation.
Texas—Oil and Gas Division, The Railroad Commission of Texas.
Utah—Utah Department of Natural Resources.
Virginia—Division of Mineral Resources, Viriginia Department of Conservation and Economic Development.
West Virginia—West Virginia Department of Mines.
Wyoming—Wyoming State Oil and Gas Conservation Commission.

Table 8.—Percentage of total U.S. crude petroleum produced, by State

State	1968	1969	1970	1971	1972
Texas	34.1	34.2	35.5	35.4	37.7
Louisiana	24.6	25.0	25.8	27.1	25.8
California	11.2	11.1	10.6	10.4	10.0
Oklahoma	6.7	6.7	6.4	6.2	6.0
Wyoming	4.3	4.6	4.6	4.3	4.1
New Mexico	3.8	3.8	3.6	3.4	3.2
Kansas	2.9	2.6	2.4	2.3	2.1
Alaska	2.0	2.2	2.4	2.3	2.1
Mississippi	1.7	1.9	1.9	1.9	1.8
Illinois	1.7	1.5	1.2	1.1	1.0
Montana	1.5	1.3	1.1	1.0	1.0
Colorado	1.0	.8	.7	.8	.9
Utah	.7	.7	.7	.7	.8
North Dakota	.7	.7	.6	.6	.6
Arkansas	.6	.5	.5	.5	.5
Michigan	.4	.4	.3	.3	.4
Kentucky	.4	.4	.3	.3	.3
Ohio	.3	.3	.3	.2	.3
Nebraska	.4	.4	.3	.3	.2
Other States	r 1.0	r .9	r .8	r .9	1.2
Total	100.0	100.0	100.0	100.0	100.0

r Revised.

Table 9.—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
		1971	1972		
East Texas	Texas	71,139	77,702	4,093,967	1,906,033
Wilmington	California	72,859	70,117	1,549,450	830,383
Kelly-Snyder	Texas	52,487	63,554	610,983	639,017
Wasson	do	51,210	62,764	700,037	799,963
McArthur River	Alaska	40,683	40,825	175,361	196,110
Slaughter	Texas	35,515	39,933	502,946	287,054
Hawkins	do	29,054	37,271	456,554	368,446
Midway Sunset	California	33,583	34,546	1,157,860	347,810
Sho-Vel-Tum	Oklahoma	36,500	33,800	934,886	215,114
Timbalier Bay	Louisiana	30,988	(3)	(3)	(3)
Caillou Island	do	31,828	29,683	473,262	226,738
Tom O'Connor	Texas	23,360	29,635	442,848	257,152
Bay Marchand Block 2	Louisiana	30,806	29,390	364,341	285,659
Kern River	California	25,542	27,197	577,458	397,261
West Delta Block 30	Louisiana	26,390	25,144	265,250	184,750
Grand Isle Block 43	do	22,776	23,095	121,938	248,134
Hastings, East and West	Texas	17,191	21,760	452,533	222,467
Huntington Beach	California	16,249	21,595	884,156	129,428
Spraberry Trend	Texas	18,688	20,617	341,060	168,940
Webster	do	16,206	20,515	367,302	207,698
Dos Cuadras	California	27,739	20,018	70,770	104,982
Grand Isle Block 16	Louisiana	21,681	19,690	178,960	171,040
Goldsmith All	Texas	20,951	19,015	541,929	133,071
South Pass Block 24	Louisiana	20,330	18,227	339,513	150,487
West Ranch	Texas	17,009	18,162	248,217	176,783
Fairway	do	14,271	18,095	92,787	1,072,130
Main Pass Block 41	Louisiana	18,469	17,678	119,315	160,685
Vacuum	New Mexico	17,030	17,445	257,618	142,382
South Pass Block 27	Louisiana	21,425	17,312	233,992	151,008
Conroe	Texas	12,994	17,278	497,076	177,924
Yates	do	13,359	17,214	569,057	1,030,943
West Delta Block 73	Louisiana	15,987	16,250	111,217	163,783
Van and Van Shallow	Texas	12,337	16,105	386,462	163,538
Thompson (all fields)	do	12,885	15,607	337,894	162,106
Cowden South (Foster, Johnson)	do	14,198	15,271	266,824	133,176
Ship Shoal Block 208	Louisiana	10,038	14,420	70,685	154,315
Sooner Trend	Oklahoma	15,240	14,390	178,124	71,876
Cogdell Area	Texas	14,235	14,054	165,426	154,574
W. Cote Blanche Bay	Louisiana	15,658	13,908	129,148	120,852
Jay	Florida	370	13,870	14,240	235,760
Panhandle	Texas	14,235	13,810	1,258,659	156,341
Timbalier South Block 135	Louisiana	13,578	(3)	(3)	(3)
Salt Creek	Texas	9,271	13,054	101,556	128,444
Garden Island Bay	Louisiana	16,096	12,993	156,042	88,958

See footnotes at end of table.

Table 9.—Production and reserves of crude petroleum in leading fields in the United States—Continued

(Thousand barrels)

Field [1]	State	Production 1971	Production 1972	Total since discovery [2]	Estimated reserves
Elk Basin	Montana, Wyoming	14,380	12,500	451,795	88,205
Oregon Basin	Wyoming	12,260	12,200	217,603	72,397
Salt Creek	do	11,750	12,060	514,400	80,600
Golden Trend	Oklahoma	12,330	11,955	384,001	15,999
South Pass Block 65	Louisiana	(3)	11,931	24,000	166,000
Rangely	Colorado	10,040	11,668	471,959	128,041
Main Pass Block 69	Louisiana	12,775	11,566	172,113	87,887
Seminole All	Texas	9,125	11,451	183,770	131,230
Dune	do	11,425	11,332	109,847	90,153
Anahuac	do	9,052	11,255	223,841	126,159
Weeks Island	Louisiana	10,183	11,053	184,243	105,757
San Ardo	California	9,939	10,816	248,708	79,245
Cowden North	Texas	9,782	10,757	248,775	76,225
Ventura	California	10,188	10,369	771,108	80,968
McElroy	Texas	9,015	10,289	286,926	73,074
South Pass Block 62	Louisiana	(3)	10,248	33,290	156,710
Levelland	Texas	9,746	10,041	208,916	116,084
Middle Ground Shoal	Alaska	11,277	9,639	68,344	116,292
Baxterville	Mississippi	9,300	9,630	152,258	82,742
Lake Washington	Louisiana	10,913	9,333	185,221	89,779
Lafitte	do	10,877	9,333	198,594	86,406
Black Bay West	do	9,892	9,113	76,434	73,566
West Bay	do	9,563	9,040	161,501	78,499
Swanson River	Alaska	11,709	8,874	134,470	63,997
Big Wells	Texas	5,840	8,844	16,661	133,339
Ward-Estes North	do	10,184	8,747	296,484	78,516
Empire Abo	New Mexico	9,520	8,735	89,107	80,893
Belridge South	California	9,211	8,705	177,725	82,084
Trading Bay	Alaska	(3)	8,690	40,511	22,835
West Delta Block 58	Louisiana	(3)	8,674	19,880	130,120
Ship Shoal Block 207	do	(3)	8,638	31,232	143,768
Cote Blanche Island	do	8,797	8,015	66,532	63,468
Means All	Texas	7,921	7,889	131,928	78,072
Hilight	Wyoming	11,300	7,800	34,194	100,806
Diamond M	Texas	7,373	7,769	182,617	92,383
Coalinga	California	7,866	7,702	619,436	59,432
Eugene Island Block 276	Louisiana	(3)	7,613	35,760	129,240
Main Pass Block 306	do	(3)	7,576	19,717	130,283
Maljamar	New Mexico	6,040	7,524	91,430	73,570
Greater Aneth	Utah	7,660	7,470	243,701	71,299
Bay St. Elaine	Louisiana	7,775	7,247	132,348	67,552
Keystone	Texas	8,322	7,024	262,473	57,527
Welch	do	(3)	7,221	75,866	74,134
Howard Glasscock	do	6,606	7,022	296,490	78,510

[1] Fields under 7 million barrels not shown for current year.
[2] Includes revisions, if any.
[3] Not reported.

Source: Oil and Gas Journal. All figures are preliminary.

Table 10.—Well completions in the United States, by quarter [1]

	1st quarter	2d quarter	3d quarter	4th quarter	Total Number	Total %
1971:						
Oil	2,972	2,851	2,769	3,266	11,858	45.9
Gas [2]	937	858	902	1,133	3,830	14.8
Dry	2,257	2,260	2,563	3,083	10,163	39.3
Total	6,166	5,969	6,234	7,482	25,851	100.0
1972:						
Oil	2,979	2,881	2,811	2,635	11,306	41.4
Gas [2]	1,021	1,081	1,212	1,614	4,928	18.1
Dry	2,686	2,493	2,699	3,179	11,057	40.5
Total	6,686	6,455	6,722	7,428	27,291	100.0

[1] Excludes service wells.
[2] Includes condensate wells.
Note:—Data by quarters adjusted to agree with annual totals.

Source: American Petroleum Institute.

Table 11.—Well completions in the United States, by State and district [1]

State and district	1971				1972			
	Oil	Gas [2]	Dry	Total	Oil	Gas [2]	Dry	Total
Alabama	8	6	48	62	13	9	93	115
Alaska	27	1	4	32	12	2	12	26
Arizona	--	2	6	8	5	1	16	22
Arkansas	127	29	186	342	96	39	209	344
California	1,459	60	286	1,805	1,045	62	288	1,395
Colorado	154	148	635	937	300	124	581	1,005
Florida	8	--	13	21	65	--	44	109
Georgia	--	--	2	2	--	--	2	2
Illinois	252	16	296	564	255	18	329	602
Indiana	81	2	132	215	92	5	172	269
Iowa	--	--	1	1	--	--	--	--
Kansas	1,099	112	1,138	2,349	880	368	1,150	2,398
Kentucky	244	135	382	761	230	166	360	756
Louisiana:								
North	390	237	365	992	291	451	374	1,116
South	398	200	544	1,142	375	234	535	1,144
Offshore	258	184	359	801	253	133	419	805
Total Louisiana	1,046	621	1,268	2,935	919	818	1,328	3,065
Michigan	81	33	188	302	87	34	188	309
Mississippi	175	13	298	486	87	13	317	417
Missouri	6	1	6	13	--	--	3	3
Montana	45	33	349	427	83	125	545	753
Nebraska	47	1	139	187	48	2	242	292
Nevada	--	--	13	13	--	--	2	2
New Mexico:								
West	44	139	79	262	64	173	106	343
East	357	47	150	554	438	65	188	691
Total New Mexico	401	186	229	816	502	238	294	1,034
New York	83	7	10	100	96	22	12	130
North Carolina	--	--	12	12	--	--	--	--
North Dakota	49	1	109	159	23	--	76	99
Ohio	391	608	158	1,157	426	721	184	1,331
Oklahoma	1,174	238	843	2,255	1,025	341	934	2,300
Pennsylvania	394	199	48	641	534	297	70	901
South Dakota	2	--	33	35	4	--	32	36
Tennessee	57	23	115	195	14	9	71	94
Texas:								
District 1	430	16	196	642	438	29	189	656
District 2	70	102	175	347	95	111	245	451
District 3	311	133	334	778	289	140	386	815
District 4	172	166	298	636	147	200	292	639
District 5	27	24	92	143	17	14	69	100
District 6	201	36	131	368	101	45	120	266
District 7B	417	52	438	907	388	54	480	922
District 7C	202	90	170	462	330	102	195	627
District 8	961	85	169	1,215	940	100	195	1,235
District 8A	510	2	153	665	474	3	158	635
District 9	503	26	338	867	620	19	329	968
District 10	76	68	53	197	122	114	63	299
Offshore	--	10	34	44	2	12	39	53
Total Texas	3,880	810	2,581	7,271	3,963	943	2,760	7,666
Utah	30	6	51	87	73	13	74	160
Virginia	--	--	--	--	--	18	--	18
West Virginia	133	496	139	768	84	488	102	674
Wyoming	405	43	445	893	345	52	567	964
Total United States	11,858	3,830	10,163	25,851	11,306	4,928	11,057	27,291

[1] Excludes service wells.
[2] Includes condensate wells.

Source: American Petroleum Institute.

Table 12.—Producing oil wells in the United States and average production per well per day, by State

State	1971		1972	
	Approximate number of oil wells producing Dec. 31	Average production per well per day (barrels) [1]	Approximate number of oil wells producing Dec. 31	Average production per well per day (barrels) [1]
Alabama	556	38.4	544	49.3
Alaska	173	1,161.6	193	1,088.3
Arizona	30	116.8	28	93.6
Arkansas	7,110	7.1	7,157	7.1
California:				
South	10,513	36.9	9,740	38.3
Central Coastal	5,376	43.4	5,386	39.3
East Central	23,721	14.8	24,069	14.5
North	58	30.5	59	31.2
Total California	39,668	24.5	39,254	24.0
Colorado	1,785	42.2	1,897	47.5
Illinois	25,361	4.2	24,716	3.8
Indiana	3,605	4.8	[2] 4,379	4.2
Kansas	42,180	5.0	41,055	4.8
Kentucky	14,657	2.2	14,616	1.8
Louisiana:				
Gulf Coast	13,988	168.5	[2] 13,624	167.7
Northern	12,841	9.6	[2] 14,138	9.0
Total Louisiana	26,829	93.6	[2] 27,762	89.3
Michigan	4,046	7.8	3,685	9.2
Mississippi	3,109	56.5	3,195	53.0
Montana	3,145	29.7	3,544	27.7
Nebraska	1,191	22.6	1,143	20.4
New Mexico:				
Southwestern	15,679	19.1	15,703	17.7
Northwestern	1,531	15.6	1,584	15.1
Total New Mexico	17,210	18.8	17,287	17.5
New York	5,860	.5	5,427	.5
North Dakota	1,466	40.6	1,401	39.3
Ohio	14,771	1.5	15,222	1.7
Oklahoma	75,572	7.6	73,745	7.6
Pennsylvania	34,029	.3	32,596	.3
South Dakota	33	21.6	29	19.3
Texas:				
District 1	10,553	5.9	10,333	6.4
District 2	5,144	39.8	4,926	44.4
District 3	11,071	39.5	10,650	45.0
District 4	8,254	24.9	7,427	23.7
District 5	3,024	24.5	2,682	31.9
District 6, except East Texas	5,581	36.0	5,210	43.1
East Texas	14,516	12.6	13,960	13.8
District 7B	11,566	8.4	11,140	9.1
District 7C	7,510	15.4	7,491	15.3
District 8	36,564	21.6	36,126	21.9
District 8A	17,189	42.1	17,423	49.4
District 9	28,938	4.9	27,522	4.8
District 10	12,786	5.5	12,343	5.3
Total Texas	172,696	19.2	167,233	20.9
Utah	870	73.6	890	82.5
West Virginia	12,112	.7	[2] 12,136	.6
Wyoming	8,952	44.5	[2] 8,950	42.7
Other States:				
Florida	78	212.3	142	419.7
Missouri	139	1.4	137	1.2
Nevada	6	41.3	6	45.5
Tennessee	78	15.9	73	7.2
Virginia	1	.9	1	(3)
Total	302	57.9	359	142.6
Total United States	517,318	18.1	508,443	18.4

[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.
[3] Less than 500 barrels.

Table 13.—Daily average demand for crude petroleum (including lease condensate) in the United States, by State of origin and month

(Thousand barrels)

State	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1971													
Alabama	20.4	16.4	20.1	19.4	32.7	20.3	27.5	18.2	7.1	29.5	31.8	9.5	21.1
Alaska	274.5	179.0	245.9	212.8	185.6	271.8	218.5	246.9	208.6	234.9	230.0	180.9	224.4
Arizona	4.5	4.1	3.6	3.8	3.6	3.4	3.5	2.6	3.0	3.1	2.9	2.7	3.4
Arkansas	50.4	52.1	50.5	51.5	45.2	52.2	49.9	49.6	49.1	40.2	52.9	51.6	49.6
California	949.3	1,018.8	967.6	973.9	990.9	980.7	1,015.1	957.2	912.8	978.4	917.6	1,013.7	972.9
Colorado	71.2	67.9	74.1	70.5	46.6	69.4	95.2	90.8	59.9	76.8	79.1	88.2	74.2
Florida	13.4	16.3	11.4	15.0	14.9	21.5	15.3	16.5	11.8	17.8	14.0	9.8	14.8
Illinois	109.1	105.4	108.1	131.8	87.6	115.1	105.5	111.2	108.9	97.7	71.4	112.2	105.3
Indiana	20.1	18.0	19.3	20.6	14.8	19.2	22.3	17.3	15.2	19.3	18.3	18.3	18.6
Kansas	210.0	205.4	230.7	213.1	175.8	241.5	222.8	229.6	232.2	214.2	193.4	197.3	213.8
Kentucky	26.9	33.0	30.0	24.1	32.4	28.0	32.6	27.3	29.3	25.0	26.8	30.0	28.8
Louisiana	2,603.4	2,620.3	2,651.8	2,595.9	2,500.4	2,690.8	2,648.2	2,608.8	2,463.4	2,515.6	2,457.1	2,573.8	2,577.4
Michigan	29.6	32.8	29.2	30.2	34.4	32.5	29.4	33.0	30.5	32.4	35.6	39.8	32.5
Mississippi	179.3	175.4	185.9	179.8	166.3	180.5	185.5	189.6	173.7	157.2	174.7	175.9	177.0
Missouri	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
Montana	117.9	111.6	95.2	109.5	75.8	100.9	99.2	90.0	103.0	86.5	100.1	91.6	98.3
Nebraska	28.2	36.5	28.5	28.0	19.8	25.6	31.2	27.9	26.0	23.2	26.2	27.3	27.3
Nevada	.2	.4	.4	.4	.4	.3	.3	.3	.3	.3	.1	.5	.3
New Mexico	363.0	360.6	314.5	336.1	298.1	343.3	328.1	321.4	293.0	338.5	317.8	286.9	324.8
New York	3.2	3.1	3.2	2.8	3.3	3.3	3.2	2.8	3.3	3.1	3.1	2.6	3.1
North Dakota	62.5	55.0	59.2	56.1	56.6	63.8	60.1	42.7	75.4	68.9	58.5	57.8	59.7
Ohio	26.5	21.5	23.7	20.8	20.6	26.2	21.2	17.6	21.8	22.7	23.1	21.7	22.3
Oklahoma	596.4	603.3	590.3	606.4	576.8	561.2	612.4	611.6	591.2	574.9	576.1	569.4	589.1
Pennsylvania	9.6	11.6	12.2	7.4	11.6	10.5	10.0	11.0	11.2	12.1	10.7	8.3	10.5
South Dakota	.4	.4	.6	.8	.8	.7	.7	.5	.7	.6	.7	.6	.6
Tennessee	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.1	1.1	1.1	1.1
Texas	3,498.4	3,687.5	3,593.9	3,503.2	3,463.4	3,391.2	3,370.8	3,224.5	3,262.2	3,306.2	3,150.4	3,334.3	3,397.3
Utah	63.9	59.3	60.8	71.6	51.7	66.7	68.5	57.6	69.1	81.7	68.0	60.5	64.9
Virginia	--	--	--	--	--	--	--	--	--	--	--	--	--
West Virginia	12.1	8.9	8.0	7.3	9.1	9.0	8.3	6.8	7.8	9.2	6.0	9.4	8.5
Wyoming	373.4	390.9	407.3	394.2	351.6	426.2	445.1	448.7	425.6	396.4	395.8	399.4	404.6
Total domestic crude	9,719.1	9,896.8	9,827.3	9,688.3	9,272.1	9,757.1	9,731.7	9,463.3	9,197.5	9,367.7	9,043.5	9,375.3	9,526.4
Foreign crude	1,269.2	1,281.8	1,323.1	1,447.6	1,458.4	1,690.8	1,688.4	1,869.1	1,926.3	1,842.7	2,092.3	2,042.6	1,662.7
Grand total 1971	10,988.3	11,178.6	11,150.4	11,135.9	10,730.5	11,447.9	11,420.1	11,332.4	11,123.8	11,210.4	11,135.8	11,417.9	11,189.1
Pennsylvania grade (included in total domestic crude above)	57.9	12.8	35.3	26.5	34.4	36.9	31.1	30.5	35.9	36.5	35.0	34.7	34.1

1972													
Alabama	37.4	22.3	26.4	25.8	28.8	23.0	30.2	26.9	22.5	31.3	29.6	19.5	27.0
Alaska	243.9	186.2	173.9	205.6	189.1	210.3	207.2	168.1	208.8	198.9	218.0	152.4	196.8
Arizona	3.1	2.8	2.9	2.6	2.8	3.2	2.4	2.9	2.5	2.6	3.1	2.2	2.8
Arkansas	55.1	49.2	51.0	50.2	51.5	50.3	46.4	50.7	51.4	58.4	51.5	47.9	51.1
California	896.4	969.0	983.1	936.6	940.8	911.4	931.9	1,019.5	942.3	971.8	915.6	1,008.2	952.4
Colorado	74.4	72.1	75.5	81.7	77.4	82.6	84.0	83.6	101.0	101.4	102.7	110.7	87.3
Florida	12.7	21.9	6.7	37.9	24.7	32.4	55.4	50.2	72.3	60.5	78.4	88.3	45.1
Illinois	113.7	108.7	98.7	106.7	100.1	106.5	106.5	106.3	101.8	99.5	92.0	97.6	103.2
Indiana	21.1	16.4	16.0	16.6	15.4	15.6	11.0	24.4	17.8	17.7	15.3	17.5	17.1
Kansas	215.6	204.2	209.9	195.4	214.1	206.1	219.0	219.1	203.8	197.6	212.8	190.5	207.4
Kentucky	32.2	36.0	28.2	22.1	20.1	34.0	28.3	23.1	26.1	26.8	29.5	21.4	27.3
Louisiana	2,476.7	2,411.0	2,486.4	2,360.9	2,468.4	2,507.4	2,481.5	2,426.2	2,409.0	2,435.5	2,432.0	2,426.1	2,443.8
Michigan	34.1	31.6	32.3	33.2	28.7	38.4	39.9	38.9	37.0	39.6	38.5	36.3	35.7
Mississippi	166.6	158.3	148.0	178.7	167.3	183.5	166.8	174.8	180.0	168.5	156.1	164.9	167.8
Missouri	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
Montana	83.0	89.7	82.2	95.6	75.5	104.3	101.8	96.8	100.1	86.5	89.0	96.2	91.7
Nebraska	28.4	25.3	31.2	19.8	26.4	21.8	24.1	27.2	26.3	22.1	21.3	23.9	24.8
Nevada	.3	.3	.3	.2	.3	.3	.2	.2	.3	.3	.3	.4	.3
New Mexico	324.3	324.9	320.2	318.4	291.5	299.0	301.8	310.5	317.1	291.4	300.2	296.8	307.9
New York	3.1	3.0	3.0	2.2	2.9	3.1	3.5	2.3	2.7	2.7	2.5	2.4	2.8
North Dakota	55.6	58.3	58.5	50.8	59.6	57.1	54.6	50.8	58.2	54.5	59.1	56.5	56.1
Ohio	28.4	30.7	26.7	21.3	25.4	30.6	27.5	29.5	28.0	22.3	27.1	27.0	27.0
Oklahoma	602.1	616.0	533.2	581.3	568.7	609.0	628.6	561.8	601.2	561.6	533.4	503.7	574.8
Pennsylvania	12.2	9.6	8.6	5.5	9.1	10.4	8.8	5.6	9.0	14.9	14.1	8.4	9.6
South Dakota	.5	.4	.7	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
Tennessee	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
Texas	3,311.5	3,314.8	3,429.3	3,625.1	3,471.9	3,641.9	3,688.2	3,704.1	3,641.6	3,500.5	3,528.7	3,817.6	3,557.0
Utah	77.6	69.0	75.7	72.9	70.3	73.9	71.9	59.0	80.7	80.7	74.2	71.2	73.1
Virginia	--	--	--	--	--	--	--	--	--	--	--	--	--
West Virginia	6.8	4.3	10.7	6.8	6.0	7.8	5.5	8.6	6.6	8.8	7.7	5.8	7.1
Wyoming	446.0	399.5	368.1	292.8	389.6	416.7	427.8	439.4	400.5	388.3	345.5	354.0	389.2
Total domestic crude	9,363.5	9,236.2	9,288.1	9,348.0	9,327.7	9,681.9	9,756.1	9,711.8	9,649.9	9,446.0	9,379.5	9,648.7	9,487.5
Foreign crude	2,075.1	2,114.1	2,048.0	1,911.5	2,031.9	2,194.7	2,100.6	2,136.2	2,461.2	2,456.8	2,427.6	2,511.7	2,205.8
Grand total 1972	11,438.6	11,350.3	11,336.1	11,259.5	11,359.6	11,876.6	11,856.7	11,848.0	12,111.1	11,902.8	11,807.1	12,160.4	11,693.3
Pennsylvania grade (included in total domestic crude above)	40.7	39.0	39.3	30.3	34.9	38.9	35.5	37.2	34.3	40.4	40.0	34.1	37.2

Table 14.—Indicated demand for crude petroleum (including lease condensate) in the United States, by State of origin and month

(Thousand barrels)

State	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1971													
Alabama	631	458	623	581	1,013	608	853	564	212	916	953	296	7,708
Alaska	8,510	5,013	7,622	6,384	5,754	8,153	6,773	7,653	6,260	7,283	6,900	5,608	81,913
Arizona	138	115	112	115	112	101	107	80	90	96	86	83	1,235
Arkansas	1,562	1,460	1,566	1,545	1,401	1,566	1,546	1,538	1,473	1,247	1,586	1,601	18,091
California	29,428	28,528	29,995	29,218	30,719	29,421	31,469	29,673	27,384	30,330	27,529	31,424	355,118
Colorado	2,208	1,902	2,296	2,115	1,445	2,081	2,951	2,814	1,798	2,382	2,374	2,734	27,100
Florida	415	456	353	449	462	645	475	512	353	551	420	304	5,395
Illinois	3,383	2,952	3,352	3,954	2,717	3,452	3,270	3,446	3,268	3,028	2,142	3,479	38,443
Indiana	622	505	599	617	458	577	692	535	456	599	550	567	6,777
Kansas	6,511	5,750	7,153	6,394	5,450	7,245	6,906	7,118	6,968	6,640	5,803	6,115	78,053
Kentucky	834	923	931	722	1,004	841	1,010	845	878	775	803	931	10,497
Louisiana	80,705	73,367	82,207	77,876	77,513	80,725	82,094	80,872	73,903	77,983	73,712	79,788	940,745
Michigan	919	919	905	906	1,066	976	911	1,023	916	1,003	1,069	1,233	11,846
Mississippi	5,557	4,912	5,764	5,395	5,156	5,414	5,752	5,878	5,210	4,874	5,243	5,454	64,609
Missouri	6	5	6	5	6	5	6	5	5	6	5	6	66
Montana	3,656	3,126	2,950	3,285	2,351	3,027	3,075	2,791	3,089	2,681	3,004	2,840	35,875
Nebraska	875	1,022	882	839	615	769	964	865	781	716	786	845	9,959
Nevada	5	12	12	11	11	10	8	9	10	9	3	15	115
New Mexico	11,254	10,096	9,749	10,083	9,240	10,300	10,170	9,964	8,790	10,494	9,534	8,894	118,568
New York	98	86	99	85	103	99	101	86	100	97	92	80	1,126
North Dakota	1,939	1,540	1,835	1,684	1,753	1,915	1,863	1,325	2,261	2,137	1,755	1,792	21,799
Ohio	821	601	736	623	637	787	661	546	655	702	693	671	8,133
Oklahoma	18,490	16,893	18,298	18,193	17,881	16,835	18,985	18,961	17,735	17,822	17,284	17,652	215,029
Pennsylvania	297	325	378	223	359	316	311	341	336	376	321	257	3,840
South Dakota	12	11	20	25	25	21	22	17	20	19	22	19	233
Tennessee	34	30	34	33	34	33	34	34	32	34	32	34	398
Texas	108,452	103,251	111,411	105,096	107,366	101,736	104,494	99,959	97,866	102,492	94,511	103,364	1,239,998
Utah	1,982	1,659	1,885	2,148	1,602	2,000	2,123	1,787	2,072	2,532	2,040	1,874	23,704
Virginia	--	--	--	--	--	--	--	--	--	--	--	1	1
West Virginia	374	249	247	218	283	270	259	212	235	285	179	292	3,103
Wyoming	11,574	10,945	12,626	11,826	10,899	12,786	13,799	13,908	12,770	12,289	11,874	12,380	147,676
Total domestic crude	301,292	277,111	304,646	290,648	287,435	292,714	301,684	293,361	275,926	290,398	271,305	290,633	3,477,153
Foreign crude	39,346	35,890	41,016	43,428	45,210	50,723	52,340	57,942	57,789	57,123	62,709	63,321	606,897
Grand total 1971	340,638	313,001	345,662	334,076	332,645	343,437	354,024	351,303	333,715	347,521	334,074	353,954	4,084,050
Daily average:													
Domestic crude	9,719.1	9,896.8	9,827.3	9,688.3	9,272.1	9,757.1	9,731.7	9,463.3	9,197.5	9,367.7	9,043.5	9,375.3	9,526.4
Domestic and foreign crude	10,988.3	11,178.6	11,150.4	11,135.9	10,730.5	11,447.9	11,420.1	11,332.4	11,123.8	11,210.4	11,135.8	11,417.9	11,189.1
Pennsylvania grade (included in total domestic above)	1,795	357	1,093	795	1,067	1,108	964	945	1,077	1,131	1,051	1,076	12,459

1972													
Alabama	1,160	647	819	775	893	690	935	833	675	969	887	603	9,886
Alaska	7,560	5,399	5,391	6,170	5,863	6,310	6,422	5,212	6,265	6,167	6,539	4,723	72,021
Arizona	97	81	90	79	86	94	75	91	75	79	92	69	1,008
Arkansas	1,709	1,426	1,581	1,505	1,595	1,509	1,438	1,571	1,542	1,809	1,545	1,485	18,715
California	27,789	28,102	30,476	28,100	29,165	27,340	28,890	31,603	28,268	30,125	27,468	31,253	348,579
Colorado	2,305	2,092	2,339	2,452	2,400	2,477	2,604	2,592	3,031	3,143	3,081	3,433	31,949
Florida	394	636	207	1,139	766	972	1,718	1,557	2,170	1,875	2,351	2,736	16,521
Illinois	3,525	3,152	3,059	3,203	3,102	3,196	3,302	3,294	3,054	3,084	2,760	3,026	37,757
Indiana	653	475	495	499	476	469	340	756	533	547	460	542	6,245
Kansas	6,682	5,923	6,507	5,864	6,636	6,184	6,789	6,792	6,114	6,126	6,384	5,905	75,906
Kentucky	997	1,043	875	664	622	1,021	877	715	784	832	886	664	9,980
Louisiana	76,779	69,919	77,078	70,827	76,520	75,221	76,927	75,213	72,270	75,502	72,959	75,209	894,424
Michigan	1,059	918	1,002	997	891	1,151	1,238	1,207	1,110	1,229	1,156	1,124	13,082
Mississippi	5,166	4,592	4,587	5,362	5,186	5,505	5,170	5,418	5,399	5,224	4,683	5,113	61,405
Missouri	5	5	5	5	5	5	5	5	5	5	5	5	60
Montana	2,574	2,601	2,549	2,869	2,341	3,130	3,157	3,001	3,002	2,682	2,671	2,983	33,560
Nebraska	879	733	966	594	819	655	747	843	789	683	639	742	9,089
Nevada	9	8	9	7	9	8	6	7	9	10	8	11	101
New Mexico	10,054	9,421	9,927	9,552	9,035	8,971	9,357	9,626	9,512	9,034	9,006	9,201	112,696
New York	96	88	92	66	90	93	108	72	81	85	74	73	1,018
North Dakota	1,724	1,691	1,814	1,524	1,849	1,712	1,693	1,575	1,746	1,688	1,773	1,753	20,542
Ohio	881	889	828	639	786	917	852	913	839	692	813	838	9,887
Oklahoma	18,664	17,863	16,530	17,440	17,630	18,271	19,486	17,414	18,037	17,409	16,002	15,616	210,362
Pennsylvania	377	277	268	166	282	312	271	175	270	463	422	260	3,543
South Dakota	14	13	23	20	20	18	17	20	18	20	17	19	219
Tennessee	17	15	17	16	17	16	17	17	16	17	16	17	198
Texas	102,657	96,129	106,309	108,754	107,629	109,258	114,334	114,826	109,248	108,516	105,863	118,346	1,301,869
Utah	2,407	2,002	2,346	2,188	2,179	2,216	2,230	1,829	2,421	2,501	2,226	2,206	26,751
West Virginia	210	124	332	205	186	235	172	267	198	273	232	180	2,614
Wyoming	13,827	11,586	11,411	8,760	12,079	12,502	13,263	13,622	12,016	12,038	10,367	10,974	142,445
Total domestic crude	290,270	267,850	287,932	280,441	289,157	290,458	302,440	301,066	289,497	292,827	281,385	299,109	3,472,432
Foreign crude	64,328	61,310	63,488	57,343	62,990	65,841	65,118	66,222	73,835	76,159	72,828	77,862	807,324
Grand total 1972	354,598	329,160	351,420	337,784	352,147	356,299	367,558	367,288	363,332	368,986	354,213	376,971	4,279,756
Daily average:													
Domestic crude	9,363.5	9,236.2	9,288.1	9,348.0	9,327.7	9,681.9	9,756.1	9,711.8	9,649.9	9,446.0	9,379.5	9,648.7	9,487.5
Domestic and foreign crude	11,438.6	11,350.3	11,336.1	11,259.5	11,359.6	11,876.6	11,856.7	11,848.0	12,111.1	11,902.8	11,807.1	12,160.4	11,693.3
Pennsylvania grade (included in total domestic above)	1,261	1,131	1,219	910	1,083	1,168	1,100	1,154	1,029	1,253	1,261	1,058	13,627

Table 15.—Refinery receipts of domestic

(Thousand

Location of refineries receiving crude oil	Total receipts of domestic crude oil	Intrastate receipts	Interstate Receipts from— PAD district I, total	PAD district II: Ill., Ind., Mich.	Kans.	Ky., Ohio, Tenn.	Nebr., N. Dak., S. Dak.	Okla.	Total
District I:									
Delaware, Maryland	3,579	--	3,012	--	--	--	--	--	--
Florida, Georgia, Virginia	1,815	--	--	--	--	--	--	--	--
New Jersey	36,275	--	586	--	--	--	--	--	--
New York	--	--	--	--	--	--	--	--	--
Pennsylvania:									
East	66,018	--	9,978	--	--	--	--	--	--
West	13,842	4,031	2,375	--	71	4,316	--	1,914	6,301
West Virginia	4,468	1,712	--	--	--	2,756	--	--	2,756
Total	125,997	5,743	15,951	--	71	7,072	--	1,914	9,057
District II:									
Illinois	270,061	17,544	--	--	2,390	--	1,103	25,332	28,825
Indiana	169,263	5,395	--	619	7,362	--	3,703	27,461	39,145
Kansas	129,090	68,120	--	--	--	--	186	23,778	23,964
Kentucky, Tennessee	65,927	4,683	94	10,249	--	46	--	--	10,295
Michigan	40,752	12,306	--	1,231	--	--	--	--	1,231
Minnesota, Wisconsin	6,456	--	--	--	--	--	5,230	--	5,230
Missouri, Nebraska	32,820	--	--	--	63	--	400	4,515	4,978
North Dakota	16,182	15,058	--	--	--	--	--	--	--
Ohio:									
East	17,201	1,325	--	1,140	--	--	--	--	1,140
West	130,837	15	--	12,340	--	89	--	55	12,484
Oklahoma	162,819	124,220	--	--	3,379	--	--	--	3,379
Total	1,041,408	248,666	94	25,579	13,194	135	10,622	81,141	130,671
District III:									
Alabama	9,917	1,736	1,874	--	--	--	--	--	--
Arkansas	17,972	13,629	--	--	--	--	--	--	--
Louisiana	508,643	427,085	218	--	--	--	--	27	27
Mississippi	93,513	14,352	--	--	--	--	--	--	--
New Mexico	16,226	16,221	--	--	--	--	--	--	--
Texas	1,089,014	860,768	1,082	--	13	--	--	1,878	1,891
Total	1,735,285	1,333,791	3,174	--	13	--	--	1,905	1,918
District IV:									
Colorado	14,408	2,915	--	--	--	--	--	--	--
Montana	29,792	13,353	--	--	--	--	--	--	--
Utah	41,186	14,210	--	--	--	--	4	--	4
Wyoming	47,029	46,214	--	--	--	--	--	--	--
Total	132,415	76,692	--	--	--	--	4	--	4
District V:									
California	414,708	354,406	--	--	--	--	--	--	--
Other States	21,054	15,609	--	--	--	--	--	--	--
Total	435,762	370,015	--	--	--	--	--	--	--
Total United States	3,470,867	2,034,907	[1] 19,219	25,579	13,278	7,207	10,626	84,960	141,650
Daily average	9,483	5,560	53	70	36	20	29	232	387

[1] Florida, 16,832; New York, 895; Virginia, 1; West Virginia, 1,491.

[2] Alaska, 49,797; Arizona, 1; California, 3,936; Nevada, 52.

crude oil, by State and district in 1972

barrels)

Interstate Receipts from—											
PAD district III					PAD district IV						
Ala., Ark., Miss.	La.	N. Mex.	Tex.	Total	Colo.	Mont.	Utah	Wyo.	Total	PAD district V, total	Total interstate receipts
169	--	--	398	567	--	--	--	--	--	--	3,579
1,792	--	--	23	1,815	--	--	--	--	--	--	1,815
5,031	20,301	--	10,357	35,689	--	--	--	--	--	--	36,275
--	--	--	--	--	--	--	--	--	--	--	--
391	20,425	--	35,224	56,040	--	--	--	--	--	--	66,018
--	--	--	--	--	--	1,135	--	--	1,135	--	9,811
--	--	--	--	--	--	--	--	--	--	--	2,756
7,383	40,726	--	46,002	94,111	--	1,135	--	--	1,135	--	120,254
2,330	85,369	17,250	106,573	211,522	4,313	796	21	7,040	12,170	--	252,517
--	8,810	10,620	67,791	87,221	1,254	7,865	--	28,383	37,502	--	163,868
--	--	919	12,101	13,020	3,290	1,504	--	19,192	23,986	--	60,970
910	47,623	--	1,925	50,458	--	146	--	251	397	--	61,244
--	3,173	--	15,712	18,885	--	--	--	8,330	8,330	--	28,446
--	--	--	--	--	--	1,226	--	--	1,226	--	6,456
--	--	5,208	18,260	23,468	--	--	--	4,374	4,374	--	32,820
--	--	--	--	--	--	1,124	--	--	1,124	--	1,124
--	11,538	--	738	12,276	--	624	--	1,836	2,460	--	15,876
4,469	46,620	1,223	62,631	114,943	--	--	--	3,395	3,395	--	130,822
--	--	561	34,233	34,794	401	--	25	--	426	--	38,599
7,709	203,133	35,781	319,964	566,587	9,258	13,285	46	72,801	95,390	--	792,742
5,202	1,105	--	--	6,307	--	--	--	--	--	--	8,181
--	934	--	3,409	4,343	--	--	--	--	--	--	4,343
16,154	--	--	65,158	81,312	--	--	--	--	--	1	81,558
--	79,161	--	--	79,161	--	--	--	--	--	--	79,161
--	--	--	--	--	--	--	5	--	5	--	5
4,206	158,646	59,604	--	222,456	24	--	2,793	--	2,817	--	228,246
25,562	239,846	59,604	68,567	393,579	24	--	2,798	--	2,822	1	401,494
--	--	--	--	--	--	821	431	10,241	11,493	--	11,493
--	--	--	--	--	--	--	--	16,439	16,439	--	16,439
--	--	15	--	15	15,705	101	--	11,099	26,905	52	26,976
--	--	--	--	--	673	97	45	--	815	--	815
--	--	15	--	15	16,378	1,019	476	37,779	55,652	52	55,723
--	--	83	666	749	--	--	11,265	--	11,265	48,288	60,302
--	--	--	--	--	--	--	--	--	--	5,445	5,445
--	--	83	666	749	--	--	11,265	--	11,265	53,733	65,747
40,654	483,705	95,483	435,199	1,055,041	25,660	15,439	14,585	110,580	166,264	[2] 53,786	1,435,960
111	1,322	261	1,189	2,883	70	42	39	302	453	147	3,923

Table 16.—Crude runs to stills and refinery receipts of crude oil in 1972, by origin of the crude and method of transportation

(Thousand barrels)

District and State	Crude runs to stills	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: Pipelines	Intrastate: Tank cars and trucks	Intrastate: Tankers and barges	Interstate: Pipelines	Interstate: Tank cars and trucks	Interstate: Tankers and barges	Refinery receipts of foreign crude: Pipelines	Refinery receipts of foreign crude: Tankers and barges
District I:												
Delaware, Maryland	37,911	1	--	−207	--	--	--	--	--	3,579	--	34,126
Florida, Georgia, Virginia	20,297	21	16,833	+205	--	--	--	--	719	1,096	--	18,708
New Jersey	173,409	2	--	−946	--	--	--	--	--	36,275	--	136,190
New York	35,215	--	895	+231	--	--	--	--	--	--	35,446	--
Pennsylvania:												
East	192,169	163	--	−1,221	--	--	--	--	--	66,018	--	125,093
West	19,055	--	4,031	−227	3,715	316	--	7,101	1,286	1,424	4,986	--
West Virginia	4,418	--	3,203	+50	1,656	47	9	2,189	547	20	--	--
Total	[1] 482,474	187	24,962	−2,115	5,371	363	9	9,290	2,552	108,412	40,432	314,117
District II:												
Illinois	299,855	49	42,286	−214	17,424	120	--	252,517	--	--	29,629	--
Indiana	190,663	--	5,395	−318	5,368	27	--	163,854	13	1	21,082	--
Kansas	133,329	73	81,398	−622	66,014	2,106	--	60,952	18	--	3,690	--
Kentucky, Tennessee	67,034	34	4,784	−91	3,195	665	823	42,798	24	18,422	1,050	--
Michigan	58,447	11	13,143	+74	9,595	2,711	--	28,446	--	--	17,780	--
Minnesota, Wisconsin	64,365	--	--	+97	--	--	--	6,456	--	--	58,006	--
Missouri, Nebraska	33,766	--	5,370	−83	--	--	--	32,697	123	--	863	--
North Dakota	18,967	--	20,314	+81	14,978	80	--	1,124	--	--	2,866	--
Ohio:												
East	19,608	--	1,325	+4	1,159	166	--	15,876	--	--	2,411	--
West	[2] 162,805	56	7,121	−322	--	15	--	130,822	--	--	[2] 31,702	--
Oklahoma	162,909	77	209,180	−167	120,994	3,226	--	38,599	--	--	--	--
Total	1,211,748	300	390,316	−1,561	238,727	9,116	823	774,141	178	18,423	169,079	--
District III:												
Alabama	9,791	60	8,122	+66	--	29	1,707	240	14	7,927	--	--
Arkansas	18,014	6	14,894	−48	12,797	832	--	4,245	98	--	--	--
Louisiana	511,757	27	910,790	+972	345,842	6,222	75,021	66,550	795	14,213	--	4,113
Mississippi	94,159	6	47,355	+15	12,319	2,033	--	79,161	--	--	--	667
New Mexico	16,261	33	111,704	−68	13,181	3,040	--	--	5	--	--	--
Texas	1,112,960	152	1,295,967	−546	817,647	8,719	34,402	133,030	64	95,152	484	23,068
Total	1,762,942	284	2,388,832	+391	1,201,786	20,875	111,130	283,226	976	117,292	484	27,848

District IV:												
Colorado	14,392	18	28,575	+177	61	2,854	--	11,366	127	--	179	--
Montana	41,049	13	28,792	+259	12,609	744	--	16,439	--	--	[3] 11,529	--
Utah	41,229	1	28,795	−44	8,154	6,056	--	25,860	1,116	--	--	--
Wyoming	48,745	--	156,794	+146	45,422	792	--	623	192	--	1,862	--
Total	145,415	32	242,956	+538	66,246	10,446	--	54,288	1,435	--	13,570	--
District V:												
California	542,190	269	358,342	+1,112	304,303	6,722	43,381	10,832	516	48,954	--	128,863
Other States [4]	136,094	41	65,459	−1,153	15,609	--	--	--	--	5,445	94,209	19,719
Total	678,284	310	423,801	−41	319,912	6,722	43,381	10,832	516	54,399	94,209	148,582
Total United States	4,280,863	1,113	3,470,867	−2,788	1,832,042	47,522	155,343	1,131,777	5,657	298,526	[5] 317,774	490,547
Daily average	11,696	3	9,483	−8	5,006	130	424	3,092	15	816	868	1,340

[1] Includes 283,279,000 barrels in Delaware River Valley.
[2] Includes some Athabasca hydrocarbons.
[3] Includes three by trucks.
[4] Alaska, Arizona, Hawaii, Nevada, Oregon and Washington.
[5] Excludes crude oil imported for direct fuel use by pipeline.

Table 17.—Transportation of petroleum products by pipelines in the United States in 1972, by month

(Thousand barrels)

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	1971 total
Turned into lines:														
Gasoline:														
Motor	126,801	118,175	130,437	128,361	141,217	141,766	143,890	148,173	140,813	139,236	135,001	138,326	1,632,196	1,468,681
Aviation	474	244	401	245	369	347	327	285	460	378	311	176	4,017	4,106
Total gasoline	127,275	118,419	130,838	128,606	141,586	142,113	144,217	148,458	141,273	139,614	135,312	138,502	1,636,213	1,472,787
Jet fuel:														
Naphtha type	1,610	1,720	2,037	1,767	1,683	1,452	1,321	1,440	1,143	1,417	1,336	1,478	18,404	24,967
Kerosine type	17,801	16,206	18,122	16,616	16,386	17,157	17,693	17,606	17,483	17,521	18,624	18,857	210,072	182,134
Total jet fuel	19,411	17,926	20,159	18,383	18,069	18,609	19,014	19,046	18,626	18,938	19,960	20,335	228,476	207,101
Kerosine	5,822	4,856	4,763	2,888	4,003	2,482	2,755	2,939	3,257	3,778	4,011	5,945	47,499	52,095
Distillate fuel oil	60,486	60,202	54,647	46,940	49,897	47,513	49,297	51,606	50,131	55,774	60,863	69,442	656,798	585,235
Natural gas liquids	31,408	31,866	32,309	29,997	31,976	31,553	32,433	33,610	32,710	36,276	36,361	38,677	399,176	340,590
Delivered from lines:														
Gasoline:														
Motor	123,402	117,187	129,933	127,718	142,583	143,576	144,520	150,249	139,551	141,586	134,671	139,949	1,634,925	1,462,852
Aviation	479	264	291	234	307	377	294	308	352	404	340	181	3,831	3,964
Total gasoline	123,881	117,451	130,224	127,952	142,890	143,953	144,814	150,557	139,903	141,990	135,011	140,130	1,638,756	1,466,816
Jet fuel:														
Naphtha type	1,441	1,865	1,923	1,752	1,609	1,574	1,364	1,381	1,143	1,434	1,363	1,414	18,263	24,825
Kerosine type	18,177	15,819	18,085	16,389	15,940	16,615	16,889	17,552	16,966	17,664	19,150	18,808	208,054	179,911
Total jet fuel	19,618	17,684	20,008	18,141	17,549	18,189	18,253	18,933	18,109	19,098	20,513	20,222	226,317	204,736
Kerosine	5,773	5,360	4,748	3,026	4,143	1,873	2,445	2,424	3,260	3,658	4,090	5,332	46,132	51,202
Distillate fuel oil	62,930	63,149	58,997	48,056	48,702	46,016	46,640	47,984	50,455	53,185	60,620	72,675	659,409	583,230
Natural gas liquids	32,996	32,586	32,795	29,425	31,429	30,987	32,467	32,908	31,149	35,800	36,618	38,166	397,326	338,796
Shortage or overage:[1]														
Gasoline:														
Motor	(429)	(236)	(85)	(7)	(396)	(129)	93	(69)	30	(383)	(246)	(335)	(2,192)	(1,418)
Aviation	21	16	(4)	34	4	39	7	(5)	8	29	26	(4)	171	133
Total gasoline	(408)	(220)	(89)	27	(392)	(90)	100	(74)	38	(354)	(220)	(339)	(2,021)	(1,285)
Jet fuel:														
Naphtha type	(19)	8	5	20	25	(15)	2	(4)	(3)	(4)	(6)	(19)	(10)	83
Kerosine type	276	24	31	165	33	198	926	(586)	83	372	121	143	1,786	1,185
Total jet fuel	257	32	36	185	58	183	928	(590)	80	368	115	124	1,776	1,268
Kerosine	174	92	106	96	264	70	(586)	859	168	56	75	165	1,539	1,356
Distillate fuel oil	(262)	(109)	(221)	(61)	(104)	47	359	316	(54)	203	(231)	(235)	(352)	(212)
Natural gas liquids	49	338	6	182	(119)	(88)	11	(70)	12	168	28	63	580	841

Stocks in lines and working tanks at end of month:														
Gasoline:														
Motor	48,161	49,385	49,974	50,624	49,654	47,973	47,250	45,243	46,475	44,508	45,084	43,796	43,796	44,333
Aviation	152	116	230	207	265	196	222	204	304	249	194	193	193	178
Total gasoline	48,318	49,501	50,204	50,831	49,919	48,169	47,472	45,447	46,779	44,757	45,278	43,989	43,989	44,511
Jet fuel:														
Naphtha type	738	585	694	689	738	631	586	649	652	639	618	701	701	550
Kerosine type	4,221	4,584	4,590	4,652	5,065	5,409	5,287	5,927	6,361	5,846	5,199	5,105	5,105	4,873
Total jet fuel	4,959	5,169	5,284	5,341	5,803	6,040	5,873	6,576	7,013	6,485	5,817	5,806	5,806	5,423
Kerosine	2,495	1,899	1,808	1,574	1,170	1,709	2,605	2,261	2,090	2,154	2,000	2,448	2,448	2,620
Distillate fuel oil	25,622	22,784	18,655	17,600	18,899	20,349	22,647	25,953	25,683	28,069	28,543	25,545	25,545	27,804
Natural gas liquids	13,288	12,230	11,738	12,128	12,794	13,448	13,403	14,175	15,724	16,032	15,747	16,195	16,195	14,925

[1] Figures in parentheses denote shortage.

Table 18.—Transportation of petroleum products by pipeline between PAD districts in the United States in 1972, by month

(Thousand barrels)

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	1971 total
From District I to District II:														
Gasoline:														
Motor	2,789	2,633	2,646	3,110	3,366	3,342	3,878	3,389	3,637	3,253	3,535	3,609	39,187	33,492
Aviation	7	6	4	--	10	8	4	6	--	--	7	--	52	52
Total gasoline	2,796	2,639	2,650	3,110	3,376	3,350	3,882	3,395	3,637	3,253	3,542	3,609	39,239	33,544
Jet fuel:														
Naphtha type	100	114	67	44	73	48	43	21	--	--	--	91	601	609
Kerosine type	122	156	142	33	60	41	68	97	141	247	215	188	1,510	1,025
Total jet fuel	222	270	209	77	133	89	111	118	141	247	215	279	2,111	1,634
Kerosine	93	61	75	34	18	24	32	48	18	60	37	46	546	787
Distillate fuel oil	758	653	732	614	568	861	810	923	803	1,011	1,042	1,056	9,831	7,741
From District II to District I:														
Gasoline (motor)	907	858	1,052	1,037	1,039	1,045	1,055	901	979	777	819	807	11,276	10,767
Jet fuel (kerosine type)	12	--	40	--	26	--	33	--	--	--	--	--	111	112
Kerosine	15	25	27	--	--	8	1	--	--	--	--	--	76	--
Distillate fuel oil	53	104	86	59	51	65	63	51	50	62	58	93	795	934
Natural gas liquids	890	449	944	838	645	808	1,061	472	1,020	1,101	961	757	9,946	10,673
From District II to District III:														
Gasoline (motor)	1,783	1,439	1,569	1,434	1,549	1,552	1,540	1,567	1,560	1,629	1,730	1,648	19,000	19,426
Jet fuel:														
Naphtha type	74	5	--	79	40	40	40	40	40	40	40	80	518	606
Kerosine type	--	--	--	--	1	--	--	1	1	--	--	1	4	5
Total jet fuel	74	5	--	79	41	40	40	41	41	40	40	81	522	611
Distillate fuel oil	235	427	396	465	363	338	337	457	466	440	286	382	4,592	4,256
Natural gas liquids	187	226	231	224	218	219	228	207	209	227	237	227	2,640	3,026
From District III to District I:														
Gasoline:														
Motor	21,929	20,963	24,479	26,416	27,569	26,449	27,049	28,465	25,701	27,969	24,252	25,611	306,852	286,026
Aviation	42	25	43	5	26	42	14	16	8	30	42	14	307	353
Total gasoline	21,971	20,988	24,522	26,421	27,595	26,491	27,063	28,481	25,709	27,999	24,294	25,625	307,159	286,379
Jet fuel:														
Naphtha type	90	131	121	112	151	58	45	40	16	100	102	101	1,067	1,574
Kerosine type	4,019	3,771	4,275	3,612	3,481	3,443	3,545	4,242	3,803	4,440	4,764	4,870	48,265	39,620
Total jet fuel	4,109	3,902	4,396	3,724	3,632	3,501	3,590	4,282	3,819	4,540	4,866	4,971	49,332	41,194
Kerosine	2,103	1,574	1,176	824	792	403	593	687	935	1,248	1,191	1,433	12,959	14,646
Distillate fuel oil	16,393	17,232	15,986	12,806	13,111	13,971	13,444	13,938	14,294	13,832	16,236	18,250	179,493	155,534
Natural gas liquids	1,731	2,122	1,252	682	649	1,029	1,133	1,420	1,121	1,474	1,754	2,236	16,603	14,705

From District III to District II:														
Gasoline:														
Motor	3,284	4,368	4,922	4,870	5,016	6,115	5,240	5,585	4,919	5,383	3,746	3,941	57,389	48,708
Aviation	77	28	72	205	109	72	103	66	169	114	118	66	1,199	1,246
Total gasoline	3,361	4,396	4,994	5,075	5,125	6,187	5,343	5,651	5,088	5,497	3,864	4,007	58,588	49,954
Jet fuel:														
Naphtha type	--	--	--	--	--	--	4	--	--	--	--	--	4	5
Kerosine type	421	354	343	314	343	464	368	529	531	525	463	301	4,956	3,115
Total jet fuel	421	354	343	314	343	464	372	529	531	525	463	301	4,960	3,120
Kerosine	298	338	148	116	64	185	26	65	253	--	110	138	1,741	3,026
Distillate fuel oil	2,340	1,291	954	682	766	836	621	1,153	1,133	1,091	1,382	948	13,197	11,593
Natural gas liquids	5,184	5,423	4,338	4,154	4,444	3,944	4,591	4,447	4,889	5,498	7,538	9,289	63,739	49,904
From District III to District IV:														
Gasoline:														
Motor	200	202	248	408	345	443	473	436	355	333	325	376	4,144	5,271
Aviation	15	16	20	19	16	22	20	24	19	21	16	18	226	225
Total gasoline	215	218	268	427	361	465	493	460	374	354	341	394	4,370	5,496
Jet fuel (kerosine type)	316	329	342	313	222	349	352	376	349	341	321	375	3,985	3,606
Kerosine	2	2	1	1	5	--	--	1	1	1	1	5	20	27
Distillate fuel oil	41	30	30	42	39	45	45	55	53	51	58	63	552	669
Natural gas liquids	191	150	73	64	56	36	39	49	66	68	163	204	1,159	1,156
From District III to District V:														
Gasoline (motor)	865	1,008	1,035	1,087	944	1,052	931	1,097	818	842	799	1,065	11,543	10,943
Jet fuel:														
Naphtha type	62	113	93	89	112	179	62	136	78	101	79	73	1,177	2,799
Kerosine type	231	141	180	166	176	152	170	137	163	113	160	149	1,938	2,179
Total jet fuel	293	254	273	255	288	331	232	273	241	214	239	222	3,115	4,978
Distillate fuel oil	321	279	308	260	439	338	397	277	332	310	301	288	3,850	3,690
From District IV to District II:														
Gasoline (motor)	264	322	335	307	375	458	478	610	417	413	362	338	4,679	4,240
Jet fuel (naphtha type)	40	39	53	66	41	28	65	42	39	50	52	73	588	501
Kerosine	6	2	2	8	5	6	2	4	4	4	4	5	52	51
Distillate fuel oil	286	265	314	266	303	290	321	242	322	249	270	262	3,390	3,206
From District IV to District V:														
Gasoline (motor)	792	801	732	833	952	843	775	805	552	754	738	673	9,250	10,358
Jet fuel:														
Naphtha type	103	116	177	117	148	47	48	31	7	45	17	24	880	1,260
Kerosine type	55	42	39	44	38	47	15	38	45	27	14	41	445	699
Total jet fuel	158	158	216	161	186	94	63	69	52	72	31	65	1,325	1,959
Distillate fuel oil	408	409	341	391	384	328	353	397	369	312	260	318	4,270	5,453

Table 19.—Pipeline tariff rates for crude petroleum and products, January 1

(Cents per barrel)

Origin	Destination	1972	1973
Crude oil:			
West Texas	Houston, Tex	$0.13–$0.16	$0.15–$0.18
Do	East Chicago, Ind	.28	.28
Do	Wood River, Ill	.28	.28
Oklahoma	Chicago, Ill	.22	.22
Do	Wood River, Ill	.19	.19
East Wyoming	Chicago, Ill	.35	.35
Do	Wood River, Ill	.32	.32
Refined products:			
Houston, Texas	Atlanta, Ga	.36	.36
Do	New York, N.Y	.31	.32
Tulsa, Oklahoma	Minneapolis, Minn	.68	.74
Salt Lake City, Utah	Spokane, Wash	.52	.54
Philadelphia, Pennsylvania	Rochester, N.Y	.24	.24

Source: Interstate Commerce Commission.

Table 20.—Receipts of domestic and foreign crude petroleum at refineries in the United States

(Million barrels)

Method of transportation	1968	1969	1970	1971	1972 p
By water:					
Intrastate	136.8	138.0	148.2	160.9	155.4
Interstate	428.8	408.8	461.8	430.0	298.5
Foreign	303.0	314.7	244.0	352.6	490.5
Total by water	868.6	861.5	854.0	943.5	944.4
By pipeline:					
Intrastate	1,673.0	1,715.1	1,730.5	1,702.2	1,832.0
Interstate	1,023.7	1,054.9	1,109.4	1,132.3	1,131.8
Foreign	169.2	199.2	236.8	260.4	317.8
Total by pipeline	2,865.9	2,969.2	3,076.7	3,094.9	3,281.6
By tank cars and trucks:					
Intrastate	40.8	41.8	37.1	37.0	47.5
Interstate	6.8	6.0	5.5	5.4	5.7
Foreign	--	--	--	--	--
Total by tank cars and trucks	47.6	47.8	42.6	42.4	53.2
Grand total	3,782.1	3,878.5	3,973.3	4,080.8	4,279.2

p Preliminary.

Table 21.—Interdistrict movements by tanker and barge of crude oil and petroleum products in 1972, by month

(Thousand barrels)

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Gulf coast to east coast, total: [1]													
Crude oil	11,978	6,954	8,749	9,447	9,575	9,078	10,411	7,424	7,617	6,038	10,735	8,888	106,894
Unfinished oils	2,139	1,835	1,493	1,808	2,107	2,030	2,382	4,500	2,262	1,447	1,000	2,260	25,263
Gasoline:													
Motor	21,543	17,319	18,685	18,590	19,070	16,940	17,381	19,097	17,833	17,681	17,324	19,503	220,966
Aviation	488	268	284	377	301	227	227	380	224	628	290	353	4,047
Total gasoline	22,031	17,587	18,969	18,967	19,371	17,167	17,608	19,477	18,057	18,309	17,614	19,856	225,013
Special naphthas	266	575	617	438	704	526	604	749	648	609	601	493	6,830
Kerosine	2,231	1,814	1,942	1,170	1,397	1,634	1,443	1,181	1,613	1,844	1,654	2,059	19,982
Distillate fuel oil	16,395	13,167	13,553	12,228	10,897	8,639	6,480	6,595	7,854	10,768	10,379	14,144	131,099
Residual fuel oil	2,644	2,346	3,229	2,724	2,399	1,977	2,159	2,783	2,411	2,460	3,185	2,072	30,389
Jet fuel:													
Naphtha type	1,559	1,264	1,517	905	1,151	1,409	1,470	707	867	514	750	410	12,523
Kerosine type	3,284	2,768	3,046	2,789	3,048	2,366	2,157	2,248	2,636	3,099	2,208	3,141	32,790
Total jet fuel	4,843	4,032	4,563	3,694	4,199	3,775	3,627	2,955	3,503	3,613	2,958	3,551	45,313
Lubricating oil	724	914	941	931	1,106	945	1,106	983	984	1,098	989	743	11,464
Wax	98	61	32	89	102	132	91	72	127	52	30	10	896
Asphalt and road oil	363	348	538	546	587	397	618	432	465	545	367	356	5,562
Liquefied gases	180	146	204	163	111	79	125	61	117	132	193	154	1,665
Petrochemical feedstocks	240	192	189	182	239	217	237	281	251	323	148	232	2,731
Other products	90	143	166	79	138	106	141	114	125	119	88	111	1,420
Total	64,222	50,114	55,185	52,466	52,932	46,702	47,032	47,607	46,034	47,357	49,941	54,929	614,521
Gulf coast to PAD District II:													
Crude oil	1,676	1,554	1,614	1,574	1,525	1,397	1,699	1,657	1,266	1,575	1,508	1,377	18,422
Unfinished oils	4	5	10	--	9	10	4	4	4	8	9	18	85
Gasoline:													
Motor	3,060	2,838	3,554	3,278	2,956	2,828	3,778	3,546	3,809	3,847	2,575	2,968	39,037
Aviation	36	52	47	90	54	37	64	53	75	41	38	22	609
Total gasoline	3,096	2,890	3,601	3,368	3,010	2,865	3,842	3,599	3,884	3,888	2,613	2,990	39,646
Special naphthas	176	265	300	308	314	252	222	216	273	199	228	261	3,014
Kerosine	293	169	189	121	112	138	40	70	139	72	165	135	1,643
Distillate fuel oil	1,036	898	1,001	1,080	815	922	853	1,088	854	920	666	819	10,952
Residual fuel oil	196	752	573	331	355	485	671	1,013	674	745	800	812	7,407

See footnote at end of table.

Table 21.—Interdistrict movements by tanker and barge of crude oil and petroleum products in 1972, by month—Continued

(Thousand barrels)

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Gulf coast to PAD District II—Continued													
Jet fuel:													
Naphtha type	--	9	--	--	19	18	--	11	18	7	18	--	100
Kerosine type	689	441	432	725	463	224	380	552	235	209	205	255	4,810
Total jet fuel	689	450	432	725	482	242	380	563	253	216	223	255	4,910
Lubricating oil	137	174	248	354	207	358	279	304	315	277	279	250	3,182
Asphalt and road oil	65	13	20	159	351	231	310	384	274	221	91	46	2,165
Liquefied gases	117	113	116	57	--	57	--	1	157	1	113	61	793
Petrochemical feedstocks	65	107	203	353	445	99	124	79	47	166	54	166	1,908
Other products	52	39	54	80	84	127	47	85	55	36	75	98	832
Total	7,602	7,429	8,361	8,510	7,709	7,183	8,471	9,063	8,195	8,324	6,824	7,288	94,959
Gulf coast to west coast:													
Crude oil	392	274	--	--	--	--	--	--	--	--	--	--	666
Unfinished oils	--	--	--	--	--	--	--	--	--	--	--	152	152
Motor gasoline	29	444	--	--	--	211	315	--	201	--	73	--	1,273
Kerosine	--	--	1	--	--	--	--	--	--	40	24	--	65
Distillate fuel oil	--	--	--	--	--	--	--	--	--	--	98	--	98
Jet fuel (naphtha type)	--	--	--	--	--	134	--	--	--	--	--	--	134
Lubricating oil	21	200	145	20	229	73	118	107	235	--	358	80	1,586
Petrochemical feedstocks	--	17	17	--	--	--	4	--	7	--	7	--	52
Other products	--	--	--	--	6	--	1	--	--	--	--	--	7
Total	442	935	163	20	235	418	438	107	443	40	560	232	4,033
West coast to east coast:													
Residual fuel oil	--	--	--	--	--	--	160	--	--	--	--	--	160
Lubricating oil	67	65	31	99	106	21	73	90	26	28	63	24	693
Other products	29	--	--	--	26	--	--	27	--	--	--	--	82
Total	96	65	31	99	132	21	233	117	26	28	63	24	935

[1] Breakdown by region shown in table 22.

Table 22.—Tanker and barge movements of crude oil and petroleum products from the Gulf coast to the east coast, by region in 1972, by month

(Thousand barrels)

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
To New England:													
Gasoline:													
Motor	3,333	2,441	3,715	3,539	3,647	2,524	3,518	3,800	2,771	3,574	3,050	3,600	39,512
Aviation	21	27	14	58	66	18	21	31	33	34	5	116	444
Total gasoline	3,354	2,468	3,729	3,597	3,713	2,542	3,539	3,831	2,804	3,608	3,055	3,716	39,956
Special naphthas	--	75	26	30	30	19	41	61	28	69	17	51	447
Kerosine	439	465	361	258	289	137	218	337	134	331	318	343	3,630
Distillate fuel oil	6,158	6,208	5,762	4,699	4,793	2,721	2,602	3,245	2,526	3,814	3,658	6,763	52,949
Residual fuel oil	794	894	1,183	744	494	385	566	595	811	340	1,652	677	9,135
Jet fuel:													
Naphtha type	242	221	100	88	195	26	178	309	176	63	348	64	2,010
Kerosine type	385	376	213	267	328	166	298	574	504	302	361	534	4,308
Total jet fuel	627	597	313	355	523	192	476	883	680	365	709	598	6,318
Lubricating oil	18	17	13	7	33	--	26	13	11	13	42	35	228
Petrochemical feedstocks	68	10	63	10	15	22	76	25	13	35	41	119	497
Other products	--	1	1	--	--	--	1	--	--	--	--	--	3
Total New England	11,458	10,735	11,451	9,700	9,890	6,018	7,545	8,990	7,007	8,575	9,492	12,302	113,163
To Central Atlantic:[1]													
Crude oil	11,888	6,855	8,692	9,388	9,497	9,038	10,286	7,365	7,504	5,997	10,708	8,840	106,058
Unfinished oils	2,139	1,835	1,493	1,808	2,066	2,030	2,382	4,500	2,262	1,447	1,000	2,260	25,222
Gasoline:													
Motor	7,949	6,027	5,400	5,207	5,779	5,765	5,297	5,914	4,987	5,339	5,641	6,013	69,318
Aviation	38	60	59	99	51	105	30	183	53	164	84	80	1,006
Total gasoline	7,987	6,087	5,459	5,306	5,830	5,870	5,327	6,097	5,040	5,503	5,725	6,093	70,324
Special naphthas	195	330	455	223	481	222	349	500	527	396	427	335	4,440
Kerosine	986	520	973	497	417	540	294	350	495	838	798	807	7,515
Distillate fuel oil	7,985	4,589	5,624	5,260	2,722	3,034	1,296	1,207	2,721	4,587	4,098	5,194	48,317
Residual fuel oil	1,560	1,274	1,092	1,303	1,290	1,131	1,141	1,521	979	1,765	1,089	865	15,010
Jet fuel:													
Naphtha type	188	100	83	26	--	194	390	--	240	257	--	12	1,490
Kerosine type	877	1,179	1,181	723	990	370	411	632	736	861	790	805	9,555
Total jet fuel	1,065	1,279	1,264	749	990	564	801	632	976	1,118	790	817	11,045
Lubricating oil	613	753	798	747	949	756	885	852	755	910	816	569	9,403
Wax	98	61	32	89	73	132	91	72	127	52	30	7	864
Asphalt and road oil	--	29	33	31	33	--	34	45	30	26	--	--	261
Petrochemical feedstocks	144	62	78	79	131	65	88	151	124	120	72	62	1,176
Other products	56	67	68	43	63	64	69	78	80	59	37	38	722
Total Central Atlantic	34,716	23,741	26,061	25,523	24,542	23,446	23,043	23,370	21,620	22,818	25,590	25,887	300,357

See footnote at end of table.

Table 22.—Tanker and barge movements of crude oil and petroleum products from the Gulf coast to the east coast, by region in 1972, by month—Continued

(Thousand barrels)

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
To Lower Atlantic:													
Crude oil	90	99	57	59	78	40	125	59	113	41	27	48	836
Unfinished oils	--	--	--	--	41	--	--	--	--	--	--	--	41
Gasoline:													
Motor	10,261	8,851	9,570	9,844	9,644	8,651	8,566	9,383	10,075	8,768	8,633	9,890	112,136
Aviation	429	181	211	220	184	104	176	166	138	430	201	157	2,597
Total	10,690	9,032	9,781	10,064	9,828	8,755	8,742	9,549	10,213	9,198	8,834	10,047	114,733
Special naphthas	71	170	136	185	193	285	214	188	93	144	157	107	1,943
Kerosine	806	829	608	415	691	957	931	494	984	675	538	909	8,837
Distillate fuel oil	2,252	2,370	2,167	2,269	3,382	2,884	2,582	2,143	2,607	2,367	2,623	2,187	29,833
Residual fuel oil	290	178	954	677	615	461	452	667	621	355	444	530	6,244
Jet fuel:													
Naphtha type	1,129	943	1,334	791	956	1,189	902	398	451	194	402	334	9,023
Kerosine type	2,022	1,213	1,652	1,799	1,730	1,830	1,448	1,042	1,396	1,936	1,057	1,802	18,927
Total	3,151	2,156	2,986	2,590	2,686	3,019	2,350	1,440	1,847	2,130	1,459	2,136	27,950
Lubricating oil	93	144	130	177	124	189	195	118	218	175	131	139	1,833
Wax	--	--	--	--	29	--	--	--	--	--	--	3	32
Asphalt and road oil	363	319	505	515	554	397	584	387	435	519	367	356	5,301
Liquefied gases	180	146	204	163	111	79	125	61	117	132	193	154	1,665
Petrochemical feedstocks	28	120	48	93	93	130	73	105	114	168	35	51	1,058
Other products	34	75	97	36	75	42	71	36	45	60	51	73	695
Total Lower Atlantic	18,048	15,638	17,673	17,243	18,500	17,238	16,444	15,247	17,407	15,964	14,859	16,740	201,001

[1] Includes data formerly shown as barge movements to District I.

Table 23.—Stocks of crude petroleum, natural gas liquids, and refined products in the United States at yearend

(Thousand barrels)

	1968	1969	1970	1971	1972
Crude petroleum:					
At refineries	78,718	76,088	80,407	73,115	70,327
Pipeline and tank farm	177,133	172,252	181,580	172,309	162,476
Producers	16,342	16,887	14,380	14,224	13,592
Total crude petroleum	272,193	265,227	276,367	259,648	246,395
Unfinished oils	93,399	97,819	98,989	100,574	94,761
Natural gasoline, plant condensate, and isopentane	5,466	5,704	7,046	6,176	6,075
Refined products	628,514	611,373	635,459	677,549	611,748
Grand total	999,572	980,123	1,017,861	1,043,947	958,979

Table 24.—Stocks of crude petroleum in the United States in 1972, by State of origin and month

(Thousand barrels)

State of origin	Jan. 1	Jan. 31	Feb. 29	Mar. 31	Apr. 30	May 31	June 30	July 31	Aug. 31	Sept. 30	Oct. 31	Nov. 30	Dec. 31
Alabama	715	285	335	298	307	252	380	337	411	615	528	498	763
Alaska	4,399	3,262	3,311	4,181	4,077	4,442	4,217	4,071	4,918	4,536	4,493	3,900	5,271
Arizona	99	91	93	90	91	91	80	92	90	101	101	73	84
Arkansas	859	671	708	697	715	702	724	870	876	860	639	595	663
California	26,937	28,546	28,203	27,242	27,734	28,206	29,337	29,868	27,744	27,864	27,054	27,872	25,380
Colorado	2,844	2,778	2,901	3,007	2,945	3,132	3,178	3,215	3,383	3,220	2,943	3,020	2,910
Florida	294	432	350	764	583	995	1,149	928	1,145	929	976	826	670
Illinois	5,787	5,460	5,182	5,194	4,819	4,761	4,477	4,034	3,716	3,431	3,216	3,254	2,904
Indiana	387	348	356	386	358	404	430	593	381	360	347	369	272
Kansas	7,766	7,288	7,524	7,611	7,943	7,820	7,819	7,184	6,664	6,530	6,482	5,800	5,604
Kentucky	1,031	854	605	585	699	946	751	683	814	802	782	675	753
Louisiana	33,028	32,271	32,649	31,790	34,478	35,089	33,249	31,711	31,933	32,663	32,492	31,895	30,431
Michigan	597	593	592	584	608	794	719	602	570	618	607	549	505
Mississippi	4,128	3,979	4,147	4,755	4,559	4,679	4,282	4,363	4,178	3,743	3,602	3,814	3,823
Montana	3,020	3,175	3,198	3,537	3,491	4,056	3,745	3,488	3,342	3,115	3,324	3,451	3,364
Nebraska	918	833	843	653	814	758	825	802	678	575	602	625	534
Nevada	2	1	1	1	1	1	1	1	1	1	1	1	1
New Mexico	8,213	7,823	7,470	7,142	6,934	7,425	7,442	7,372	7,032	6,379	6,524	6,333	6,042
New York	30	30	30	30	30	30	30	30	30	30	30	30	30
North Dakota	1,387	1,417	1,380	1,357	1,526	1,405	1,391	1,428	1,575	1,525	1,574	1,486	1,469
Ohio	1,350	1,339	1,258	1,235	1,305	1,307	1,189	1,122	1,075	957	1,020	928	821
Oklahoma	15,873	14,905	15,059	15,993	15,474	15,917	14,758	13,239	12,533	11,604	11,360	11,838	13,144
Pennsylvania	769	681	670	664	758	780	757	769	896	905	767	639	667
Texas	93,304	90,288	92,536	95,649	95,583	101,025	100,426	98,209	95,535	94,731	98,434	100,641	93,120
Utah	2,558	2,347	2,460	2,396	2,412	2,380	2,402	2,365	2,818	2,672	2,452	2,508	2,377
West Virginia	539	551	636	547	561	604	609	657	627	644	595	577	602
Wyoming	17,258	16,117	16,767	18,255	20,786	20,476	19,298	17,577	15,537	14,844	14,411	14,567	14,824
Total domestic crude	234,092	226,365	229,264	234,643	239,591	248,477	243,665	235,610	228,502	224,254	225,356	226,764	217,028
Foreign crude:													
Districts I–IV	15,728	16,028	15,910	15,223	16,732	19,085	17,400	19,015	18,032	16,102	18,694	15,098	18,654
District V	9,828	8,619	7,771	9,036	10,313	11,928	10,316	11,218	11,442	10,446	9,698	9,444	10,713
Total foreign crude	25,556	24,647	23,681	24,259	27,045	31,013	27,716	30,233	29,474	26,548	28,392	24,542	29,367
Total crude stocks	259,648	251,012	252,945	258,902	266,636	279,490	271,381	265,843	257,976	250,802	253,748	251,306	246,395
Pennsylvania grade (included in total domestic crude)	2,158	2,129	2,153	2,055	2,158	2,195	2,154	2,162	2,154	2,141	1,985	1,740	1,707

Table 25.—Stocks of crude petroleum in the United States in 1972, by State and month

(Thousand barrels)

State	Jan. 1	Jan. 31	Feb. 29	Mar. 31	Apr. 30	May 31	June 30	July 31	Aug. 31	Sept. 30	Oct. 31	Nov. 30	Dec. 31
Alabama	879	564	643	868	1,086	856	903	673	814	747	791	635	854
Alaska	1,076	626	441	883	887	538	373	592	734	541	789	765	1,020
Arizona	447	448	448	448	446	445	445	444	446	445	445	447	444
Arkansas	1,195	1,201	1,314	1,215	1,214	1,212	1,237	1,383	1,451	1,368	1,146	1,106	999
California, Nevada, Oregon, Washington	40,552	39,584	39,229	39,354	40,737	43,894	43,257	44,615	43,482	42,171	39,993	40,469	40,133
Colorado	1,590	1,413	1,651	1,680	1,811	1,929	1,907	1,987	1,953	1,988	1,780	1,753	1,863
Florida, Georgia, South Carolina, Virginia	1,117	984	1,474	1,033	1,408	1,623	1,182	1,143	1,634	976	1,102	733	1,377
Hawaii	453	1,127	781	1,143	1,290	914	917	678	838	901	1,141	657	717
Illinois	17,181	17,151	16,538	16,737	19,229	20,088	18,285	16,871	16,035	15,497	16,275	16,243	16,084
Indiana	4,034	4,000	3,697	3,621	3,405	3,929	3,862	3,819	3,647	3,498	3,236	3,163	3,427
Iowa, Missouri	6,676	6,115	6,357	6,154	6,329	6,711	6,978	5,961	5,960	5,313	6,094	6,407	6,188
Kansas	11,101	10,303	10,275	10,316	11,645	11,186	11,429	10,818	9,928	9,794	9,376	9,232	9,228
Kentucky, Tennessee	4,726	4,742	4,434	4,407	4,238	4,939	4,638	4,611	4,658	4,377	4,481	4,446	4,189
Louisiana	17,990	16,884	17,703	17,867	19,562	20,752	19,748	18,456	20,654	18,597	18,864	18,920	18,893
Maryland	382	418	387	479	418	497	435	439	364	226	278	295	262
Massachusetts, Delaware, Rhode Island	697	996	580	421	709	1,386	1,398	1,522	1,258	638	548	979	610
Michigan	1,578	1,663	1,647	2,013	2,376	2,617	2,417	2,505	2,635	2,899	3,138	2,161	2,734
Minnesota, Wisconsin	2,090	2,061	2,192	2,168	2,875	2,526	2,447	2,083	2,086	1,816	2,205	2,288	2,127
Mississippi	5,448	5,483	5,658	5,924	5,769	5,552	5,668	5,645	5,245	5,299	5,357	5,183	5,708
Montana	2,435	2,512	2,710	2,880	3,169	3,203	2,993	2,806	2,670	2,426	2,699	2,945	3,032
Nebraska	1,545	1,569	1,637	1,578	1,644	1,660	1,576	1,485	1,477	1,481	1,393	1,510	1,434
New Jersey	5,449	6,532	5,756	6,210	6,287	4,841	5,387	6,244	6,472	4,830	6,072	5,652	4,503
New Mexico	3,960	3,793	3,925	3,949	3,958	3,932	3,715	3,603	3,767	3,525	3,548	3,556	3,636
New York	155	259	357	326	428	348	243	413	396	388	379	354	386
North Dakota	1,166	1,166	1,145	1,154	1,132	1,161	1,252	1,237	1,326	1,320	1,256	1,262	1,288
Ohio	7,260	6,769	6,829	6,742	7,699	7,932	7,425	6,730	5,940	6,439	5,957	6,170	5,811
Oklahoma	17,508	16,711	16,758	17,713	16,504	17,626	17,262	15,637	15,078	14,746	15,546	16,146	14,984
Pennsylvania	8,399	8,046	7,172	6,900	6,974	8,693	7,034	7,879	6,417	6,939	6,847	5,991	6,545
Texas	81,621	77,583	79,870	81,817	80,019	84,915	84,872	84,600	81,102	81,781	83,336	82,258	78,331
Utah	1,290	1,191	1,324	1,369	1,285	1,350	1,175	1,135	1,138	1,257	1,222	1,179	1,174
West Virginia	555	548	550	565	519	576	622	624	613	656	670	670	627
Wyoming	9,093	8,570	9,463	10,968	11,594	11,659	10,299	9,205	7,758	7,923	7,784	7,731	7,787
Total	259,648	251,012	252,945	258,902	266,636	279,490	271,381	265,843	257,976	250,802	253,748	251,306	246,395

Table 26.—Stocks of crude petroleum in the United States in 1972, by classification and State and month

(Thousand barrels)

Classification and State	Jan. 1	Jan. 31	Feb. 29	Mar. 31	Apr. 30	May 31	June 30	July 31	Aug. 31	Sept. 30	Oct. 31	Nov. 30	Dec. 31
At refineries:													
Alabama	148	209	227	236	211	256	156	185	158	209	218	153	214
Alaska	157	134	63	117	122	70	71	85	84	120	101	104	126
Arkansas	170	166	133	117	153	149	121	142	147	138	108	135	122
California, Nevada, Oregon, Washington	20,749	18,817	19,526	19,556	21,399	23,385	22,285	23,333	23,349	22,341	20,779	21,003	20,475
Colorado	356	348	474	421	512	582	460	496	527	547	411	390	533
Florida, Georgia, South Carolina, Virginia	839	828	1,195	839	1,167	1,249	932	1,015	1,374	811	756	575	1,044
Hawaii	453	1,127	781	1,143	1,290	914	917	678	838	901	1,141	657	717
Illinois	3,764	3,847	3,771	3,575	3,833	4,206	4,433	3,930	3,457	3,341	4,474	4,171	3,550
Indiana	1,469	1,463	1,365	1,303	1,335	1,224	1,209	1,286	1,223	1,218	1,277	1,263	1,151
Kansas	2,019	1,871	1,858	1,842	1,676	1,928	1,918	1,756	1,620	1,561	1,340	1,375	1,397
Kentucky, Tennessee	1,199	1,286	1,243	1,137	1,470	1,345	1,300	1,413	1,161	1,206	1,237	1,394	1,108
Louisiana	5,259	5,576	5,929	6,087	6,392	6,839	7,237	6,596	7,257	6,220	6,430	5,915	6,231
Maryland	382	418	387	479	413	497	435	439	364	226	278	295	262
Massachusetts, Delaware, Rhode Island	697	996	580	421	709	1,386	1,398	1,522	1,258	638	548	979	610
Michigan	657	767	849	815	771	889	816	805	828	835	804	685	731
Minnesota, Wisconsin	929	954	1,075	1,053	1,566	1,409	1,346	1,350	1,204	1,151	1,156	1,238	1,026
Mississippi	833	814	889	869	894	865	914	902	904	925	912	713	848
Missouri	380	372	338	306	312	381	321	306	271	289	277	322	298
Montana	553	634	741	895	1,073	1,012	935	760	706	563	721	915	812
Nebraska	29	31	29	25	25	29	23	29	26	22	25	28	28
New Jersey	5,449	6,532	5,756	6,210	6,287	4,841	5,387	6,244	6,472	4,830	6,072	5,652	4,503
New Mexico	222	232	242	220	264	306	255	237	185	128	125	167	154
New York	125	229	327	296	398	318	213	383	366	358	349	324	356
North Dakota	153	180	190	175	155	170	272	274	335	337	312	323	234
Ohio	2,111	2,136	2,127	2,144	2,466	2,376	2,228	2,013	1,851	1,919	1,949	1,763	1,793
Oklahoma	1,523	1,713	1,695	2,043	1,898	1,912	1,915	1,719	1,603	1,545	1,438	1,366	1,356
Pennsylvania	7,169	6,960	6,136	5,866	5,778	7,551	5,984	6,785	5,225	5,810	5,922	5,197	5,721
Texas	14,098	13,227	14,759	14,658	14,955	15,216	15,401	16,353	15,141	17,069	16,487	14,313	13,552
Utah	551	483	559	609	530	578	519	495	445	465	464	544	507
West Virginia	83	67	53	68	72	101	86	166	169	189	155	125	133
Wyoming	589	671	580	701	804	853	850	779	816	819	830	780	735
Total at refineries	73,115	73,088	73,877	74,226	78,930	82,837	80,337	82,476	79,364	76,731	77,096	72,864	70,327

Table 26.—Stocks of crude petroleum in the United States in 1972, by classification and State and month—Continued

(Thousand barrels)

Classification and State	Jan. 1	Jan. 31	Feb. 29	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:													
Alabama	631	257	322	542	783	506	649	391	564	444	479	387	546
Alaska	877	447	317	706	704	400	189	409	596	352	633	603	839
Arkansas	931	935	1,081	998	968	965	1,018	1,143	1,206	1,132	940	873	779
California, Arizona	18,262	19,251	18,347	18,386	17,950	18,857	19,673	19,842	18,823	18,603	17,935	18,212	18,433
Colorado	1,107	927	1,025	1,049	1,143	1,164	1,270	1,305	1,240	1,255	1,171	1,147	1,130
Florida	261	135	257	175	199	333	199	99	231	140	319	114	293
Illinois	13,150	13,037	12,501	12,898	15,129	15,618	13,589	12,678	12,316	11,891	11,536	11,811	12,269
Indiana	2,531	2,503	2,298	2,284	2,036	2,671	2,619	2,499	2,390	2,246	1,925	1,866	2,242
Iowa, Missouri	6,296	5,743	6,019	5,848	6,017	6,330	6,657	5,655	5,689	5,024	5,817	6,085	5,890
Kansas	8,826	8,173	8,159	8,224	9,743	9,005	9,261	8,808	8,062	7,988	7,790	7,610	7,575
Kentucky, Tennessee	3,476	3,405	3,140	3,219	2,717	3,543	3,287	3,147	3,446	3,120	3,193	3,001	3,030
Louisiana	10,458	9,129	9,629	9,645	11,158	11,643	10,266	9,648	11,164	10,019	10,123	10,671	10,522
Michigan	839	814	716	1,116	1,523	1,651	1,524	1,623	1,730	1,987	2,257	1,399	1,907
Minnesota, Wisconsin	1,161	1,107	1,117	1,115	1,309	1,117	1,101	733	882	665	1,049	1,050	1,101
Mississippi	4,244	4,316	4,409	4,711	4,623	4,372	4,439	4,428	4,039	4,057	4,128	4,159	4,549
Montana	1,591	1,586	1,650	1,672	1,784	1,870	1,737	1,725	1,665	1,564	1,679	1,731	1,899
Nebraska	1,418	1,440	1,510	1,455	1,521	1,533	1,455	1,358	1,353	1,361	1,270	1,384	1,308
New Mexico	2,513	2,283	2,444	2,524	2,594	2,603	2,439	2,332	2,544	2,372	2,385	2,367	2,494
New York	--	--	--	--	--	--	--	--	--	--	--	--	--
North Dakota	920	885	862	884	893	906	894	882	919	916	868	878	990
Ohio	5,074	4,558	4,627	4,523	5,158	5,481	5,122	4,642	4,014	4,445	3,933	4,332	3,943
Oklahoma	15,037	14,023	14,096	14,721	13,705	14,765	14,409	12,974	12,539	12,265	13,139	13,803	12,643
Pennsylvania	1,097	960	902	900	1,062	1,013	921	965	1,063	1,000	796	665	695
Texas	62,657	59,461	60,212	62,271	60,585	64,812	64,647	63,391	61,160	59,938	62,021	63,180	59,992
Utah	660	630	676	682	707	710	580	571	620	692	678	532	546
West Viriginia	307	316	332	332	282	310	371	293	279	302	350	380	329
Wyoming	7,985	7,367	8,357	9,754	10,269	10,290	8,948	7,896	6,435	6,576	6,439	6,415	6,532
Total	172,309	163,688	165,005	170,634	174,562	182,468	177,264	169,437	164,969	160,354	162,853	164,655	162,476
Lease stocks	14,224	14,236	14,063	14,042	13,144	14,185	13,780	13,930	13,643	13,717	13,799	13,787	13,592
Total stocks:													
1972	259,648	251,012	252,945	258,902	266,636	279,490	271,381	265,843	257,976	250,802	253,748	251,306	246,395
1971	276,367	269,806	266,864	267,246	271,445	284,320	279,337	273,235	272,417	269,771	265,899	265,552	259,648

Table 27.—Value of crude petroleum at wells in the United States, by State
(Dollars)

State	1971		1972	
	Total value at wells (thousands)	Average value per barrel	Total value at wells (thousands)	Average value per barrel
Alabama	23,496	3.00	30,466	3.07
Alaska	257,562	3.24	235,444	3.23
Arizona	3,918	3.17	3,226	3.25
Arkansas	56,805	3.11	58,335	3.15
California	975,076	2.72	940,430	2.71
Colorado	92,855	3.39	109,171	3.41
Illinois	135,621	3.47	121,013	3.47
Indiana	22,770	3.42	20,964	3.42
Kansas	276,433	3.52	259,578	3.52
Kentucky	35,925	3.36	32,599	3.36
Louisiana:				
Gulf Coast	3,198,487	3.59	3,044,933	3.59
Northern	161,223	3.55	156,726	3.54
Total Louisiana	3,359,710	3.59	3,201,659	3.59
Michigan	38,859	3.27	41,556	3.20
Mississippi	201,808	3.15	192,465	3.15
Montana	104,128	3.01	103,924	3.07
Nebraska	34,010	3.38	29,423	3.38
New Mexico:				
Southeastern	374,822	3.42	349,586	3.43
Northwestern	27,780	3.15	27,192	3.16
Total New Mexico	402,602	3.40	376,778	3.41
New York	5,292	4.70	4,897	4.81
North Dakota	70,805	3.27	67,647	3.28
Ohio	29,801	3.60	35,179	3.76
Oklahoma	725,611	3.40	709,033	3.41
Pennsylvania	17,699	4.66	16,414	4.77
South Dakota	604	2.59	574	2.62
Texas:				
Gulf Coast	890,658	3.73	971,022	3.73
East Texas Field	240,224	3.54	254,051	3.52
West Texas	2,040,348	3.40	2,203,363	3.41
Panhandle	90,481	3.46	83,773	3.43
Rest of State	1,000,064	3.46	1,023,868	3.43
Total Texas	4,261,775	3.48	4,536,077	3.48
Utah	71,886	3.04	80,773	3.04
West Virginia	11,609	3.91	12,047	4.50
Wyoming	459,079	3.10	432,071	3.09
Other States [1]	17,259	2.91	54,767	3.17
Total United States	11,692,998	3.39	11,706,510	3.39

[1] Florida, Missouri, Nevada, Tennessee, Virginia.

Table 28.—Posted price per barrel of petroleum at wells in the United States in 1972, by grade [1]

(Dollars)

Grade	Price per barrel
Pennsylvania grade:	
Bradford and Allegheny districts	4.88
Southwest Pennsylvania	4.17
Corning grade	3.42
Western Kentucky	3.60
Indiana-Illinois	3.60
Coldwater, Michigan	3.35
Oklahoma-Kansas:	
34°–34.9° API	3.42
36°–36.9° API	3.50
Texas, Panhandle (Carson, Gray, Hutchinson, and Wheeler Counties), 35°–35.9° API	3.41
West Texas, 30°–30.9° API (sweet)	3.36
Lea County, New Mexico, 30°–30.9° API (sour)	3.25
South Texas, Mirando, 24°–24.9° API	3.65
East Texas	3.60
Conroe, Texas	3.70
Texas:	
30°–30.9° API	3.45
20°–20.9° API	3.35
Louisiana, 30°–30.9° API	3.55
Caddo-Pine Island, Louisiana, 36°–36.9° API	3.44
Magnolia Smackover Limestone, Arkansas, 31°–31.9° API	3.07
Elk Basin, Wyoming (including Montana), 30°–30.9° API	3.16
California:	
Coalinga, 32°–32.9° API	3.41
Kettleman Hills, 37°–37.9° API	3.66
Midway Sunset, 19°–19.9° API	2.68
Wilmington, 24°–24.9° API	3.03

[1] No price change listed in 1972.

Source: Platt's Oil Price Handbook.

Table 29.—Wholesale price index, crude petroleum

(1967 = 100) [1]

Month	1968	1969	1970	1971	1972
January	99.0	99.7	106.0	113.2	113.2
February	99.0	99.9	106.0	113.2	113.2
March	99.0	103.7	106.0	113.2	113.2
April	99.0	104.8	106.0	113.2	113.2
May	99.0	104.7	106.0	113.2	113.2
June	99.3	104.5	106.0	113.2	113.2
July	99.4	104.5	104.8	113.2	113.2
August	99.7	104.5	104.8	113.2	114.7
September	99.7	104.5	104.8	113.2	114.7
October	99.7	104.5	104.8	113.2	114.7
November	99.7	104.5	104.8	113.2	114.7
December	99.7	104.5	113.2	113.2	114.7
Average	99.4	103.7	106.1	113.2	113.8

[1] Reference base prior to 1970: (1957–59 = 100).

Source: Bureau of Labor Statistics, U.S. Department of Labor.

Table 30.—Average monthly price of petroleum products in the United States, 1971–72

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	1971	13.16	12.95	12.80	12.49	13.13	12.98	12.88	12.88	12.81	12.75	12.75	12.75	12.86
	1972	12.73	12.63	12.67	12.88	12.88	12.88	12.88	12.88	12.88	12.88	12.88	12.88	12.83
Tank wagon prices to dealers at 55 cities on first of month	1971	18.38	18.26	17.43	17.07	16.81	17.82	18.25	19.35	18.84	19.08	17.43	18.59	18.11
	1972	18.04	17.92	16.96	17.21	16.52	17.15	17.71	17.31	18.92	18.47	18.13	18.30	17.72
At service station (including all taxes)	1971	36.75	36.53	35.24	34.97	34.59	34.59	36.61	38.08	37.70	37.99	35.74	37.13	36.44
	1972	36.53	37.05	34.79	35.34	34.41	35.20	35.82	35.29	37.95	37.29	36.87	37.02	36.13
Kerosine (cents per gallon):														
No. 1 range at Chicago district	1971	12.21	12.21	11.84	11.28	11.43	11.75	11.75	11.97	12.00	12.00	12.00	12.00	11.87
	1972	12.00	11.84	11.70	11.70	11.70	11.74	11.75	11.75	11.75	12.08	12.13	12.13	11.86
No. 1 fuel oil at Oklahoma	1971	11.08	10.92	10.64	10.31	10.23	10.25	10.25	10.25	10.25	10.25	10.25	10.25	10.41
	1972	10.25	10.25	10.25	10.25	10.25	10.25	10.25	10.25	10.25	10.26	10.50	10.50	10.29
Kerosine (or No. 1 fuel oil) at New York Harbor	1971	12.31	12.43	12.33	12.20	12.22	12.23	12.23	12.23	12.23	12.23	12.23	12.23	12.26
	1972	12.23	12.23	12.23	12.23	12.23	12.23	12.23	12.23	12.23	12.23	12.23	12.23	12.23
Kerosine (or No. 1 fuel oil) at Tampa	[1] 1971	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50
Distillate and diesel fuel oil (cents per gallon):														
No. 2 fuel oil at refineries, Oklahoma	1971	10.33	10.17	9.89	9.56	9.48	9.50	9.50	9.50	9.50	9.50	9.50	9.50	9.66
	1972	9.50	9.50	9.50	9.50	9.50	9.50	9.50	9.50	9.50	9.50	9.75	9.75	9.54
No. 2 fuel oil at New York Harbor	1971	11.92	12.00	12.00	12.00	11.85	11.85	11.85	11.85	11.85	11.85	11.85	11.85	11.89
	1972	11.85	11.85	11.85	11.85	11.85	11.85	11.85	11.85	11.85	11.85	11.85	11.85	11.85
Diesel oil, shore plants, New York	1971	12.22	12.30	12.30	12.30	12.15	12.15	12.15	12.15	12.15	12.15	12.15	12.15	12.19
	1972	12.15	12.15	12.15	12.15	12.15	12.15	12.15	12.15	12.15	12.44	12.45	12.45	12.22
Diesel oil for ships (dollars per barrel):														
New York	1971	5.42	5.42	5.42	5.42	5.42	5.42	5.32	5.22	5.22	5.36	5.08	5.08	5.32
	1972	5.08	5.16	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.32	5.32	5.18
New Orleans	1971	5.12	5.12	5.12	5.12	5.12	5.12	5.02	4.92	4.92	5.07	5.10	5.10	5.07
	1972	5.10	4.95	4.95	4.89	4.89	4.89	4.89	4.89	4.89	4.89	5.04	5.04	4.94
San Pedro	1971	6.21	6.21	5.91	5.91	5.91	5.91	5.91	5.91	5.91	5.91	5.91	5.91	5.96
	1972	5.95	6.06	6.06	6.06	6.06	6.06	6.06	6.06	6.06	6.06	6.06	6.06	6.05
Residual fuel oil (dollars per barrel):														
No. 6 fuel oil at refineries, Oklahoma	1971	2.68	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.61
	1972	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
No. 5 fuel oil at New York Harbor	1971	4.43	4.43	4.47	4.60	4.60	4.60	4.60	4.60	4.60	4.50	4.35	4.35	4.51
	1972	4.35	4.34	4.05	4.05	4.05	4.05	4.05	4.05	4.05	4.05	4.05	4.10	4.10
Bunker "C" for ships:														
New York	[2] 1971	3.75	3.75	3.75	3.92	3.92	3.85	3.73	3.65	3.65	3.54	3.30	3.30	3.68
	1972	3.41	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45
New Orleans	[2] 1971	--	--	--	--	--	--	3.65	3.65	3.65	3.62	3.30	3.30	[3] 3.53
	1972	3.42	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45
San Pedro	1971	3.30	3.30	3.76	3.80	3.80	3.80	3.80	3.80	3.80	3.77	3.45	3.45	3.65
	1972	3.50	3.64	3.64	3.64	3.64	3.64	3.64	3.64	3.64	3.64	3.64	3.64	3.63

See footnote at end of table.

Table 30.—Average monthly price of petroleum products in the United States, 1971–72—Continued

Monthly average and grade	Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average for year
Lubricating oil (cents per gallon):														
East Coast:														
200 viscosity, at 100, 0–100 pour test, 95 Viscosity Index	1971	23.39	23.50	23.50	23.50	23.50	23.50	23.50	23.50	23.50	23.50	23.50	23.50	23.49
	1972	23.50	23.50	23.50	23.50	23.50	23.50	23.50	23.50	23.50	23.50	24.24	24.69	23.66
500 viscosity at 100, 0–100 pour test, 95 Viscosity Index	1971	25.27	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.44
	1972	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	25.50	26.23	26.69	25.66
South Texas: 500 viscosity, No. 2½–3½ color [3]	[1] 1971	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Liquid petroleum gas (propane) (cents per gallon):														
New York Harbor/Philadelphia	1971	9.00	9.00	9.00	8.58	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.63
	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
Oklahoma	1971	6.25	6.25	6.13	5.75	5.75	5.75	5.75	5.75	5.75	5.67	5.25	5.25	5.78
	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
Baton Rouge	1971	6.73	6.73	6.23	5.73	5.73	5.73	5.73	5.73	5.73	6.14	5.73	5.73	5.97
	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

[1] No change in price during 1972.
[2] As of Oct. 29, 1971. Includes trade voluntary allowance of 10 cents per barrel.
[3] Partial average.

Table 31.—Supply, demand and stocks of all oils by PAD districts in 1972

(Thousand barrels)

	PAD districts						United States
	I	II	III	IV	I–IV	V	
Domestic production:							
Crude oil and lease condensate	24,033	384,237	2,393,590	232,500	3,034,360	421,008	3,455,368
Natural gas plant liquids	8,118	88,675	509,969	16,541	623,303	14,913	638,216
Receipts from other districts	1,200,651	941,533	34,674	19,533	10,304	66,455	--
Imports:							
Natural gasoline and plant condensate	798	16,478	--	11,162	28,438	2,990	31,428
Crude oil	354,549	171,338	28,331	14,126	568,344	242,791	811,135
Unfinished oils	30,715	--	1,548	--	32,263	13,442	45,705
Refined products	760,635	23,320	16,474	5,461	805,890	41,098	846,988
Other hydrocarbons and hydrogen input	--	539	3,376	131	4,046	6,072	10,118
Total new supply	2,379,499	1,626,120	2,987,962	299,454	5,106,948	808,769	5,838,958
Unaccounted for crude oil	1,413	1,825	−4,832	7,922	6,328	3,873	10,201
Processing gain	15,790	41,248	61,294	1,464	119,796	22,365	142,161
Total supply	2,396,702	1,669,193	3,044,424	308,840	5,233,072	835,007	5,991,320
Change in stocks of all oil	−31,266	−29,111	−25,088	−1,710	−87,175	+2,207	−84,968
Total disposition of primary supply	2,427,968	1,698,304	3,069,512	310,550	5,320,247	832,800	6,076,288
Exports:							
Crude oil	--	--	--	--	--	187	187
Refined products	7,489	3,761	38,294	47	49,591	31,690	81,281
Shipments to other districts	55,259	59,978	1,986,748	150,557	66,455	10,304	--
Crude losses	[e] 998	[e] 1,594	[e] 1,586	[e] 153	4,331	310	4,641
Domestic demand for products:							
Gasoline:							
Motor gasoline	790,864	807,406	323,150	68,576	1,989,996	343,781	2,333,777
Aviation gasoline	4,666	3,870	3,376	688	12,600	4,028	16,628
Total gasoline	795,530	811,276	326,526	69,264	2,002,596	347,809	2,350,405
Jet fuel:							
Naphtha type	23,375	16,510	15,063	2,476	57,424	31,071	88,495
Kerosine type	121,449	60,838	18,383	7,329	207,999	85,996	293,995
Total jet fuel	144,824	77,348	33,446	9,805	265,423	117,067	382,490
Ethane (including ethylene)	1,712	11,308	92,588	42	105,650	551	106,201
Liquefied gases	57,076	126,872	192,529	15,012	391,489	22,160	413,649
Kerosine	43,759	25,002	13,436	2,062	84,259	1,595	85,854
Distillate fuel oil	511,233	323,243	101,644	30,445	966,565	99,484	1,066,049
Residual fuel oil	686,554	80,084	31,757	9,622	808,017	117,630	925,647
Petrochemical feedstocks	9,163	15,991	91,843	333	117,330	6,537	123,867
Special naphtha	7,793	8,296	10,419	273	26,781	5,107	31,888
Lubricants	20,951	13,426	11,573	871	46,821	5,980	52,801
Wax	2,923	969	781	128	4,801	609	5,410
Coke	13,113	31,220	30,451	3,561	78,345	9,974	88,319
Asphalt	43,980	56,247	32,774	11,475	144,476	19,312	163,788
Road oil	673	3,851	111	1,373	6,008	1,530	7,538
Still gas for fuel	21,530	44,064	67,256	5,424	138,274	32,719	170,993
Miscellaneous products	3,408	3,774	5,750	103	13,035	2,245	15,280
Total domestic demand	2,364,222	1,632,971	1,042,884	159,793	5,199,870	790,309	5,990,179
Stocks of all oils							
Crude oil and lease condensate	14,310	67,494	108,421	13,856	204,081	42,314	246,395
Unfinished oils	14,123	19,881	33,536	2,975	70,515	24,246	94,761
Natural gasoline and plant condensate	35	1,251	4,438	143	5,867	208	6,075
Refined products	174,923	170,512	179,117	14,084	538,636	73,112	611,748
Total	203,391	259,138	325,512	31,058	819,099	139,880	958,979

[e] Estimate.

Table 32.—Salient statistics of the major refined petroleum products in the United States

(Thousand barrels)

Product	1969	1970	1971	1972 p
Isopentane:				
Production	3,457	3,865	5,565	7,251
Stocks at plants	10	7	31	99
Used at refineries	3,491	3,868	5,541	7,183
Natural gasoline:				
Production	154,472	161,274	159,732	156,450
Stocks end of year:				
At plants	3,358	4,316	3,647	3,285
At refineries	1,557	1,765	1,485	1,418
Total stocks	4,915	6,081	5,132	4,703
Used at refineries	154,001	160,108	160,681	156,879
Plant condensate:				
Production	34,133	31,972	25,754	22,022
Stocks end of year:				
At plants	547	507	594	763
At refineries	232	451	419	510
Total stocks	779	958	1,013	1,273
Imports	NA	2,258	13,321	31,428
Used at refineries	34,332	34,051	39,020	53,190
Finished gasoline:				
Production:				
At refineries	2,022,407	2,099,911	2,197,550	2,315,768
At gas processing plants	5,745	5,347	5,023	4,182
Total gasoline production	2,028,152	2,105,258	2,202,573	2,319,950
Stocks end of year:				
At refineries	217,084	214,150	223,544	217,025
At plants	308	198	227	124
Total stocks	217,392	214,348	223,771	217,149
Imports	22,709	24,320	21,658	24,787
Exports	2,449	1,370	1,649	954
Domestic demand	2,042,546	2,131,252	2,213,159	2,350,405
Motor gasoline:				
Production:				
At refineries	1,995,947	2,080,199	2,179,093	2,298,775
At gas processing plants	5,745	5,347	5,023	4,182
Total motor gasoline production	2,001,692	2,085,546	2,184,116	2,302,957
Stocks end of year:				
At refineries	210,891	209,057	219,125	212,770
At plants	308	198	227	124
Total motor gasoline stocks	211,199	209,255	219,352	212,894
Imports	22,709	24,320	21,658	24,787
Exports	703	461	410	425
Domestic demand	2,016,995	2,111,349	2,195,267	2,333,777
Aviation gasoline:				
Production	26,460	19,712	18,457	16,993
Stocks end of year	6,193	5,093	4,419	4,255
Exports	1,746	909	1,239	529
Domestic demand	25,551	19,903	17,892	16,628
Jet fuel:				
Production	321,718	301,913	304,674	310,029
Stocks end of year	28,073	27,610	27,737	25,493
Imports	45,539	52,696	65,712	71,174
Exports	1,730	2,094	1,536	957
Domestic demand	361,731	352,978	368,723	382,490
Naphtha type:				
Production:				
At refineries	104,748	84,060	85,317	76,565
At gas processing plants	18	21	9	--
Total production	104,766	84,081	85,326	76,565
Stocks end of year:				
At refineries	8,537	6,618	6,988	6,147
At plants	19	3	2	--
Total stocks	8,556	6,621	6,990	6,147

See footnotes at end of table.

Table 32.—Salient statistics of the major refined petroleum products in the United States—Continued

(Thousand barrels)

Product	1969	1970	1971	1972 p
Jet fuel—Continued				
Naphtha type—Continued				
Imports	5,134	7,005	11,092	11,998
Exports	1,730	2,094	1,317	911
Domestic demand	108,518	90,927	94,732	88,495
Kerosine type:				
Production	216,952	217,832	219,348	233,464
Stocks end of year	19,517	20,989	20,747	19,346
Imports	40,405	45,691	54,620	59,176
Exports	--	--	219	46
Domestic demand	253,213	262,051	273,991	293,995
Ethane (including ethylene):				
Production:				
At gas processing plants	63,027	73,434	80,524	100,691
At refineries	9,159	9,460	9,266	9,197
Total production	72,186	82,894	89,790	109,888
Stocks end of year:				
At plants	2,182	1,319	3,365	7,052
At refineries	--	--	--	--
Total stocks	2,182	1,319	[1] 3,365	[1] 7,052
Domestic demand:				
Plant ethane	63,057	74,297	78,478	97,004
Refinery ethane and/or ethylene	9,159	9,460	9,266	9,197
Total domestic demand	72,216	83,757	87,744	106,201
Liquefied gases:				
Production:				
At gas processing plants (LPG)	315,430	326,177	337,110	344,045
At refineries (LRG):				
For fuel use	75,659	80,870	88,648	84,514
For chemical use	38,703	35,657	32,304	36,668
Total production at refineries	114,362	116,527	120,952	121,182
Total production	429,792	442,704	458,062	465,227
Stocks end of year:				
LPG stocks:				
At plants	51,799	59,276	80,294	67,807
At refineries	571	794	3,693	3,077
Total LPG stocks	52,370	60,070	83,987	70,884
LRG stocks:				
For fuel use	4,782	5,433	6,992	7,487
For chemical use	268	221	369	294
Total LRG stocks	5,050	5,654	7,361	7,781
Total stocks	57,420	65,724	[1] 91,348	[1] 78,665
Imports	12,651	18,921	25,655	32,401
Exports	12,797	9,955	9,390	11,469
LPG used at refineries	72,764	80,307	79,695	85,193
Domestic demand:				
LPG for fuel and chemical use	263,402	251,051	249,767	292,887
LRG for fuel use	74,447	80,219	87,089	84,019
LRG for chemical use	35,561	31,789	32,152	36,743
Total domestic demand	373,410	363,059	369,008	413,649
Propane (including propylene):				
Production:				
At gas processing plants	195,346	202,494	212,143	218,039
At refineries:				
For fuel use	57,022	63,409	71,934	69,038
For chemical use	19,721	20,090	21,512	25,024
Total production at refineries	76,743	83,499	93,446	94,062
Total production	272,089	285,993	305,589	312,101

See footnotes at end of table.

Table 32.—Salient statistics of the major refined petroleum products in the United States—Continued

(Thousand barrels)

Product	1969	1970	1971	1972 p
Propane (including propylene)—Continued				
Stocks end of year:				
Plant propane stocks:				
At plants	31,375	38,791	56,779	48,219
At refineries	4	84	769	190
Total plant propane stocks	31,379	38,875	57,548	48,409
Refinery propane and/or propylene stocks:				
For fuel use	3,083	4,301	5,050	4,959
For chemical use	215	146	263	193
Total refinery propane and/or propylene stocks	3,298	4,447	5,313	5,152
Total stocks	34,677	43,322	62,861	53,561
Imports	5,251	9,467	11,606	15,851
Exports	2,412	2,165	4,665	6,502
Plant propane used at refineries	1,632	1,530	3,273	3,934
Domestic demand:				
Plant propane	209,702	200,770	197,138	232,593
Refinery propane and/or propylene:				
For fuel use	56,886	62,191	71,185	69,129
For chemical use	19,579	20,159	21,395	25,094
Total refinery propane and/or propylene domestic demand	76,465	82,350	92,580	94,223
Total domestic demand	286,167	283,120	289,718	326,816
Butane (including butylene):				
Production:				
At gas processing plants	86,471	87,253	88,544	88,924
At refineries:				
For fuel use	13,535	13,514	13,765	12,940
For chemical use	10,987	8,693	5,886	5,673
Total production at refineries	24,522	22,207	19,651	18,613
Total production	110,993	109,460	108,195	107,537
Stocks end of year:				
Plant butane stocks:				
At plants	13,330	14,397	13,571	10,389
At refineries	270	414	1,614	1,425
Total plant butane stocks	13,600	14,811	15,185	11,814
Refinery butane and/or butylene stocks:				
For fuel use	1,448	912	1,448	2,161
For chemical use	36	35	11	15
Total refinery butane and/or butylene stocks	1,484	947	1,459	2,176
Total stocks	15,084	15,758	16,644	13,990
Imports	7,400	9,454	14,049	16,550
Exports	3,086	1,655	4,725	4,967
Plant butane used at refineries	40,268	43,758	46,061	44,512
Domestic demand:				
Plant butane	53,415	50,083	51,433	59,366
Refinery butane and/or butylene:				
For fuel use	13,023	14,050	13,229	12,227
For chemical use	10,993	8,694	5,910	5,669
Total refinery butane and/or butylene	24,016	22,744	19,139	17,896
Total domestic demand	77,431	72,827	70,572	77,262

See footnotes at end of table.

Table 32.—Salient statistics of the major refined petroleum products in the United States—Continued

(Thousand barrels)

Product	1969	1970	1971	1972 p
Butane-propane mixture:				
Production:				
At gas processing plants	6,711	5,677	4,173	3,535
At refineries:				
For fuel use	5,102	3,947	2,949	2,536
For chemical use	6,289	5,353	3,029	3,892
Total production at refineries	11,391	9,300	5,978	6,428
Total production	18,102	14,977	10,151	9,963
Stocks end of year:				
Plant butane-propane mixture:				
At plants	240	733	815	944
At refineries	91	35	38	31
Total plant butane-propane mixture stocks	331	768	853	975
Refinery butane-propane mixture:				
For fuel use	251	220	494	367
For chemical use	--	--	3	2
Total refinery butane-propane mixture stocks	251	220	497	369
Total stocks	582	988	1,350	1,344
Exports	7,299	6,135	--	--
Plant butane-propane mixture used at refineries	3,013	2,822	2,896	2,485
Domestic demand:				
Plant butane-propane mixture	285	198	1,192	928
Refinery butane-propane mixture:				
For fuel use	4,538	3,978	2,675	2,663
For chemical use	3,268	1,438	3,026	3,893
Total refinery butane-propane mixture	7,806	5,416	5,701	6,556
Total domestic demand	8,091	5,614	6,893	7,484
Isobutane:				
Production:				
At gas processing plants	26,902	30,753	32,250	33,547
At refineries	1,706	1,521	1,877	2,079
Total production	28,608	32,274	34,127	35,626
Stocks end of year:				
Plant isobutane:				
At plants	6,854	5,355	9,129	8,255
At refineries	206	261	1,272	1,431
Total plant isobutane stocks	7,060	5,616	10,401	9,686
Refinery isobutane	17	40	92	84
Total stocks	7,077	5,656	10,493	9,770
Plant isobutane used at refineries	27,851	32,197	27,465	34,262
Domestic demand: Refinery isobutane for chemical use	1,721	1,498	1,825	2,087
Kerosine (including range oil):				
Production:				
At refineries	101,738	94,635	86,256	79,027
At gas processing plants	1,121	1,077	1,243	1,063
Total production	102,859	95,712	87,499	80,090
Stocks end of year:				
At refineries	26,531	27,564	24,237	19,068
At plants	249	284	201	43
Total stocks	26,780	27,848	24,438	19,111
Imports	965	1,451	189	526
Exports	155	121	181	89
Domestic demand	100,369	95,974	90,917	85,854

See footnotes at end of table.

Table 32.—Salient statistics of major refined petroleum products in the United States—Continued

(Thousand barrels)

Product	1969	1970	1971	1972 p
Distillate fuel oil:				
Production:				
At refineries	846,863	895,656	910,727	962,405
At gas processing plants	1,541	1,441	1,370	1,220
Total production	848,404	897,097	912,097	963,625
Crude used directly as distillate	654	743	1,548	944
Stocks end of year:				
At refineries	171,664	195,213	[2] 190,584	[2] 154,284
At plants	50	58	38	35
Total stocks	171,714	195,271	190,622	154,319
Imports	50,883	53,826	55,783	66,391
Exports	1,123	898	2,761	1,214
Domestic demand	900,262	927,211	971,316	1,066,049
Residual fuel oil:				
Production	265,906	257,510	274,684	292,519
Crude used directly as residual	4,334	4,317	4,565	3,322
Stocks end of year	58,395	53,994	59,681	55,216
Imports	461,611	557,845	577,700	[3] 637,401
Exports	16,891	19,785	13,217	12,060
Domestic demand	721,924	804,288	838,045	925,647
Petrochemical feedstocks (excluding LRG): [4]				
Production	98,356	100,381	110,948	124,026
Stocks end of year	2,845	3,619	3,886	2,766
Imports: Naphtha–400°	40	5,352	5,109	3,178
Exports: Other	3,848	3,776	5,265	4,457
Domestic demand:				
Still gas	9,985	12,564	16,158	14,678
Naphtha–400°	57,569	57,279	56,821	58,075
Other	27,094	31,340	37,546	51,114
Total domestic demand	94,648	101,183	110,525	123,867
Special naphthas:				
Production:				
At refineries	28,397	30,196	28,255	32,096
At gas processing plants	492	384	329	264
Total production	28,889	30,580	28,584	32,360
Stocks end of year:				
At refineries	6,281	6,184	5,373	5,224
At plants	11	9	11	8
Total stocks	6,292	6,193	5,384	5,232
Imports	3,191	2,297	1,824	863
Exports	2,019	1,586	1,455	1,487
Domestic demand	29,598	31,390	29,762	31,888
Lubricants:				
Production	65,080	66,183	65,473	65,349
Stocks end of year	14,088	14,712	15,049	13,271
Imports	163	224	10	669
Exports:				
Grease	257	293	235	226
Oil	16,139	15,797	15,590	14,769
Total exports	16,396	16,090	15,825	14,995
Domestic demand	48,782	49,693	49,321	52,801
Wax (1 barrel = 280 pounds):				
Production	6,049	6,294	6,939	6,148
Stocks end of year	997	993	1,117	1,061
Imports	158	117	93	335
Exports	1,623	1,808	1,660	1,129
Domestic demand	4,588	4,607	5,248	5,410
Coke (5 barrels = 1 short ton):				
Production				
Marketable coke	52,006	59,107	62,313	66,814
Catalyst coke	50,862	48,764	46,801	52,951
Total production	102,868	107,871	109,114	119,765
Stocks end of year	5,198	5,297	7,445	7,816
Exports	23,035	30,557	27,069	31,075
Domestic demand	80,830	77,215	79,897	88,319

See footnotes at end of table.

Table 32.—Salient statistics of the major refined petroleum products in the United States—Continued

(Thousand barrels)

Product	1969	1970	1971	1972 p
Asphalt (5.5 barrels = 1 short ton):				
Production	135,691	146,658	157,039	155,294
Stocks end of year	16,753	15,779	21,202	21,638
Imports	4,761	6,201	7,216	9,263
Exports	464	356	306	333
Domestic demand	143,290	153,477	158,526	163,788
Road oil:				
Production	9,086	9,393	8,755	7,943
Stocks end of year	880	632	900	1,305
Domestic demand	8,756	9,641	8,487	7,538
Still gas for fuel: Production	160,363	163,905	156,967	170,993
Miscellaneous products: Production:				
At refineries	17,139	14,746	14,271	15,364
At gas processing plants	805	924	1,156	1,028
Total production	17,944	15,670	15,427	16,392
Stocks end of year:				
At refineries	2,345	2,105	1,593	1,632
At plants	19	15	11	22
Total stocks	2,364	2,120	1,604	1,654
Exports	919	1,071	1,028	1,062
Domestic demand	16,617	14,843	14,915	15,280
Unfinished oils (net):				
Input (+) Output (−)	+34,346	+38,091	+43,608	+51,518
Stocks end of year	97,819	98,989	100,574	94,761
Imports	38,766	39,261	45,193	45,705

p Preliminary. NA Not available.

1 Includes underground stocks at plants and refineries, in thousands of barrels. At plants: ethane, 1971, 2,431; 1972, 6,143; propane, 1971, 49,721; 1972, 39,340; butane, 1971, 11,178; 1972, 7,917; butane-propane mixture, 1971, 271; 1972, 324; and isobutane, 1971, 8,403; 1972, 7,407. At refineries (includes LRG): propane, 1971, 5,235; 1972, 4,427; butane, 1971, 2,528; 1972, 3,176; butane-propane mixture, 1971, 370; 1972, 260; and isobutane, 1971, 1,218; 1972, 1,236.

2 Includes No. 4 fuel oil, in thousands of barrels: 1971, 5,160; 1972, 3,723. Data for previous years are not available.

3 Includes 10,419,000 barrels of foreign crude oil to be burned as fuel. Data for previous years are not available.

4 Produced at petroleum refineries. Data for LRG petrochemical feedstocks are included with those for "Liquefied gases."

NOTE:—"Stocks at refineries" include stocks at refineries and bulk terminals operated by refining and refined products pipeline companies, including pipeline fill. "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 33.—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.
1971												
Gasoline:												
Motor	232,079	245,310	245,659	230,349	221,714	209,595	203,010	204,225	207,885	208,525	208,959	219,352
Aviation	4,943	5,206	4,906	4,641	4,518	4,376	4,177	4,149	4,430	4,372	4,604	4,419
Total gasoline	237,022	250,516	250,565	234,990	226,232	213,971	207,187	208,374	212,315	212,897	213,563	223,771
Jet fuel:												
Naphtha type	6,910	7,040	6,917	6,606	6,692	6,934	7,202	6,681	6,645	6,795	7,005	6,990
Kerosine type	20,680	19,992	20,214	10,658	21,822	21,819	21,645	21,015	21,437	20,364	20,934	20,747
Total jet fuel	27,590	27,032	27,131	27,264	28,514	28,753	28,847	27,696	28,082	27,159	27,939	27,737
Ethane (including ethylene)	1,331	1,511	1,844	2,066	2,083	2,034	2,110	2,372	2,310	2,739	3,076	3,365
Liquefied gases [1]	53,394	46,454	49,166	58,220	70,813	81,840	93,021	101,603	105,836	106,644	100,516	91,348
Kerosine	23,921	19,662	19,231	19,539	21,610	23,602	26,392	28,030	27,806	28,218	26,765	24,438
Distillate fuel oil	158,740	128,706	112,872	113,693	125,815	145,790	172,373	196,973	210,136	222,969	214,780	190,622
Residual fuel oil	53,878	48,900	49,425	50,623	55,371	58,735	63,716	65,904	66,519	68,547	59,934	59,681
Petrochemical feedstocks	3,104	3,260	3,160	3,343	3,297	3,471	3,503	3,290	3,318	3,199	3,246	3,886
Special naphthas	6,213	6,029	5,682	5,727	5,448	5,308	5,208	5,279	4,997	5,212	5,463	5,384
Lubricants	15,152	15,172	15,463	15,167	15,446	15,375	15,148	14,805	15,044	14,874	14,913	15,049
Wax	1,071	1,088	1,037	1,041	1,070	1,095	1,104	1,070	1,070	1,066	1,120	1,117
Coke	5,443	5,636	5,850	5,753	6,242	5,959	6,596	7,693	9,499	8,967	7,919	7,445
Asphalt	19,667	22,732	25,500	27,743	28,282	25,243	23,840	20,159	18,077	16,512	17,593	21,202
Road oil	1,039	1,303	1,751	1,970	2,070	1,777	1,659	1,333	1,056	944	879	900
Miscellaneous	1,872	1,804	1,732	1,707	1,835	1,756	1,653	1,683	1,747	1,787	1,685	1,604
Unfinished oils	94,379	90,562	90,492	98,636	100,648	102,891	103,625	100,322	99,378	103,355	103,921	100,574
Total 1971	703,816	670,367	660,901	667,482	694,776	717,600	755,982	786,586	807,190	825,089	803,312	778,123
1972												
Gasoline:												
Motor	239,912	250,236	237,177	225,552	215,089	200,353	200,975	192,967	199,927	207,915	209,032	212,894
Aviation	4,679	4,573	4,036	3,994	4,080	3,930	3,696	3,784	3,769	3,825	4,134	4,255
Total gasoline	244,591	254,809	241,213	229,546	219,169	204,283	204,671	196,751	203,696	211,740	213,166	217,149
Jet fuel:												
Naphtha type	6,658	6,339	6,966	6,471	6,093	5,889	5,844	6,517	6,149	5,933	5,647	6,147
Kerosine type	19,199	18,891	20,181	21,097	22,792	22,467	23,585	25,132	24,448	22,700	21,003	19,346
Total jet fuel	25,857	25,230	27,147	27,568	28,885	28,356	29,429	31,649	30,597	28,633	26,650	25,493
Ethane (including ethylene)	3,265	3,677	4,112	4,589	5,127	5,423	5,690	5,888	6,086	6,170	6,719	7,052
Liquefied gases [1]	79,161	68,206	68,575	75,362	87,601	95,787	104,150	109,003	113,265	109,323	96,448	78,665
Kerosine	21,339	17,408	15,693	16,363	17,132	18,640	21,481	22,060	22,917	21,956	21,351	19,111
Distillate fuel oil	160,078	122,194	101,765	98,324	112,926	128,779	155,593	174,702	190,289	195,570	182,619	154,319
Residual fuel oil	59,440	50,891	51,566	49,425	53,035	56,109	60,230	61,399	63,692	63,758	57,702	55,216
Petrochemical feedstocks	3,236	3,115	2,801	3,094	2,852	2,831	2,727	2,824	2,749	2,355	2,721	2,766
Special naphthas	5,594	5,575	4,903	5,231	5,087	4,585	4,842	4,958	5,025	4,818	5,132	5,232
Lubricants	15,325	15,136	14,429	13,722	13,729	13,895	13,426	13,283	13,278	13,249	12,856	13,271

Wax	1,121	1,097	1,106	1,067	1,024	970	1,031	993	1,014	1,038	1,036	1,061
Coke	8,049	8,798	8,006	7,747	7,686	7,944	8,304	8,067	7,742	7,848	7,423	7,816
Asphalt	24,072	26,557	29,245	31,037	30,979	28,590	26,365	20,727	18,828	17,208	18,447	21,638
Road oil	1,021	1,291	1,752	2,030	1,950	2,042	1,846	1,663	1,460	1,284	1,270	1,305
Miscellaneous	1,620	1,521	1,315	1,266	1,460	1,571	1,780	1,474	1,682	1,702	1,557	1,654
Unfinished oils	102,763	99,110	103,137	106,890	109,535	114,054	109,574	104,871	106,043	103,482	101,221	94,761
Total 1972	756,527	704,615	676,765	673,261	698,177	713,859	751,139	760,312	788,363	790,134	756,318	706,509

[1] Includes LRG used for petrochemical feedstocks.

Table 34.—Input and output of petroleum products at refineries in the United States

(Thousand barrels)

	1968	1969	1970	1971	1972 p
INPUT					
Crude petroleum:					
Domestic	3,308,044	3,363,602	3,485,332	3,481,543	3,473,880
Foreign [1]	466,316	516,003	482,171	606,266	806,983
Total crude petroleum	3,774,360	3,879,605	3,967,503	4,087,809	4,280,863
Unfinished oils rerun (net)	26,152	34,346	38,091	43,608	51,518
Total crude and unfinished oils rerun	3,800,512	3,913,951	4,005,594	4,131,417	4,332,381
Natural gas liquids:					
Liquefied petroleum gases	72,652	72,764	80,307	79,695	85,193
Natural gasoline	148,132	157,492	163,976	166,222	164,062
Plant condensate	38,552	34,332	34,051	39,020	53,190
Total natural gas liquids	259,336	264,588	278,334	284,937	302,445
Other hydrocarbons and hydrogen [2]	3,377	4,213	6,238	6,074	10,118
OUTPUT					
Gasoline:					
Motor gasoline [3]	1,902,264	1,995,947	2,080,199	2,179,093	2,298,775
Aviation gasoline	31,563	26,460	19,712	18,457	16,993
Total gasoline [3]	1,933,827	2,022,407	2,099,911	2,197,550	2,315,768
Jet fuel:					
Naphtha type [3]	121,165	104,748	84,060	85,317	76,565
Kerosine type	193,486	216,952	217,832	219,348	233,464
Total jet fuel [3]	314,651	321,700	301,892	304,665	310,029
Ethane (including ethylene)	9,446	9,159	9,460	9,266	9,197
Liquefied refinery gas:					
For fuel use	71,102	75,659	80,870	88,648	84,514
For chemical use	37,539	38,703	35,657	32,304	36,668
Total liquefied refinery gas	108,641	114,362	116,527	120,952	121,182
Kerosine [3]	100,545	101,738	94,635	86,256	79,027
Distillate fuel oil [3]	839,373	846,863	895,656	910,727	962,405
Residual fuel oil	275,814	265,906	257,510	274,684	292,519
Petrochemical feedstocks:					
Still gas	9,844	9,985	12,564	16,158	14,678
Naphtha–400°	55,077	57,389	54,154	54,096	57,027
Other	30,501	30,982	33,663	40,694	52,321
Total petrochemical feedstocks	95,422	98,356	100,381	110,948	124,026
Special naphthas [3]	27,643	28,397	30,196	28,255	32,096
Lubricants	65,684	65,080	66,183	65,473	65,349
Wax [4]	5,887	6,049	6,294	6,939	6,148
Coke [4]	95,190	102,868	107,871	109,114	119,765
Asphalt [4]	135,460	135,691	146,658	157,039	155,294
Road oil	6,826	9,086	9,393	8,755	7,943
Still gas for fuel	149,796	160,363	163,905	156,967	170,993
Miscellaneous [3]	15,711	17,139	14,746	14,271	15,364
Processing gain (−) or loss (+)	−116,691	−122,412	−131,052	−139,433	−142,161

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 natural gasoline plants shown as direct transfers and omitted from the input and output at refineries.

[4] Conversion factors: 280 pounds of wax to the barrel; 5.0 barrels of coke to the short ton; 5.5 barrels of asphalt to the short ton.

Table 35.—Input and output at refineries in the United States, by month

(Thousand barrels)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
INPUT 1971													
Crude petroleum													
Domestic	305,620	276,397	304,104	292,953	287,682	293,854	302,703	294,498	276,284	288,419	270,829	288,200	3,481,543
Foreign	39,316	35,869	40,974	43,269	45,117	50,651	52,304	57,907	57,750	57,097	62,732	63,280	[1] 606,266
Total crude petroleum	344,936	312,266	345,078	336,222	332,799	344,505	355,007	352,405	334,034	345,516	333,561	351,480	4,087,809
Unfinished oils rerun (net)	+7,629	+6,408	+2,744	−4,876	+1,008	+1,284	+3,686	+7,989	+5,311	+381	+3,318	+8,726	+43,608
Total crude and unfinished oils rerun	352,565	318,674	347,822	331,346	333,807	345,789	358,693	360,394	339,345	345,897	336,879	360,206	4,131,417
Natural gas liquids:													
Liquefied petroleum gases	8,269	7,129	6,208	5,224	5,030	5,053	5,382	5,439	6,134	7,708	8,663	9,456	79,695
Natural gasoline	14,103	12,881	14,088	12,991	14,322	14,340	14,330	14,543	13,697	13,641	13,272	14,014	166,222
Plant condensate	2,858	2,697	3,151	2,944	2,772	3,505	3,440	3,328	3,746	3,703	2,967	3,909	39,020
Total natural gas liquids	25,230	22,707	23,447	21,159	22,124	22,898	23,152	23,310	23,577	25,052	24,902	27,379	284,937
Other hydrocarbons	448	343	449	478	430	532	552	443	439	732	563	665	6,074
OUTPUT 1971													
Gasoline:													
Motor gasoline [2]	183,378	164,880	178,914	168,447	172,357	179,508	190,748	194,323	183,649	186,145	181,268	195,476	2,179,093
Aviation gasoline	1,387	1,686	1,372	1,509	1,467	1,457	1,486	1,853	2,093	1,587	1,490	1,070	18,457
Total gasoline [2]	184,765	166,566	180,286	169,956	173,824	180,965	192,234	196,176	185,742	187,732	182,758	196,546	2,197,550
Jet fuel:													
Naphtha-type [2]	6,787	6,472	7,087	7,098	7,176	7,061	6,880	6,627	7,553	7,390	7,645	7,541	85,317
Kerosine-type	19,111	17,209	19,236	18,021	18,581	18,269	17,512	18,246	17,490	18,878	18,490	18,305	219,348
Total jet fuel [2]	25,898	23,681	26,323	25,119	25,757	25,330	24,392	24,873	25,043	26,268	26,135	25,846	304,665
Ethane (including ethylene)	797	727	761	777	682	840	745	772	679	765	853	868	9,266
Liquefied gases:													
LRG for fuel use	7,113	6,967	7,916	7,566	7,665	7,759	7,849	8,402	6,811	6,872	6,315	7,413	88,648
LRG for chemical use	2,445	2,386	2,763	2,649	2,688	2,819	2,866	2,641	2,589	2,805	2,799	2,854	32,304
Total liquefied gases	9,558	9,353	10,679	10,215	10,353	10,578	10,715	11,043	9,400	9,677	9,114	10,267	120,952
Kerosine [2]	9,352	8,332	8,228	6,577	5,839	6,443	7,082	5,993	5,496	7,095	7,011	8,808	86,256
Distillate fuel oil [2]	80,811	72,178	77,898	76,551	74,935	76,679	77,671	77,831	71,215	74,644	72,078	78,236	910,727
Residual fuel oil	31,321	27,099	26,533	22,238	18,978	20,042	19,964	19,176	19,742	19,719	22,295	27,577	274,684
Petrochemical feedstocks:													
Still gas	1,135	1,575	1,242	1,433	1,131	1,372	1,509	1,966	1,688	1,158	984	965	16,158
Naphtha-400°	4,372	4,549	4,864	4,801	4,378	4,442	3,898	4,204	4,128	5,014	4,210	5,236	54,096
Other	2,230	2,134	2,757	3,686	3,535	3,497	3,573	3,315	4,055	3,875	3,845	4,192	40,694
Total petrochemical feedstocks	7,737	8,258	8,863	9,920	9,044	9,311	8,980	9,485	9,871	10,047	9,039	10,393	110,948
Special naphthas [2]	2,370	1,979	2,651	2,314	2,253	2,270	2,495	2,185	2,309	2,746	2,371	2,312	28,255

See footnotes at end of table.

Table 35.—Input and output at refineries in the United States, by month—Continued

(Thousand barrels)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Lubricants:													
Bright stock	526	613	534	631	675	653	526	478	610	619	652	590	7,107
Neutral	2,412	2,163	2,507	2,352	2,590	2,392	2,548	2,773	2,274	2,366	2,508	2,426	29,311
Other grades	2,324	2,165	2,750	2,680	2,438	2,716	2,647	2,351	2,322	2,522	1,979	2,161	29,055
Total lubricants	5,262	4,941	5,791	5,663	5,703	5,761	5,721	5,602	5,206	5,507	5,139	5,177	65,473
Wax:													
Microcrystalline	92	87	109	109	89	96	93	96	209	82	111	71	1,244
Crystalline-fully refined	253	217	268	234	275	245	223	249	241	255	320	292	3,072
Crystalline-other	180	249	267	266	252	287	191	224	166	172	182	187	2,623
Total wax [3]	525	553	644	609	616	628	507	569	616	509	613	550	6,939
Coke [3]	9,013	8,259	9,267	9,159	9,015	9,106	9,173	9,749	8,933	9,263	8,914	9,263	109,114
Asphalt [3]	8,219	7,732	10,084	12,087	14,053	16,308	17,375	17,396	16,206	15,045	12,772	9,762	157,039
Road oil	529	345	594	519	792	975	1,361	1,367	897	665	434	277	8,755
Still gas for fuel	13,616	11,433	13,129	12,664	13,326	13,505	14,002	13,639	12,748	12,860	12,464	13,581	156,967
Miscellaneous products [2]	1,263	1,169	1,239	1,368	1,130	1,133	1,163	1,266	1,050	1,149	1,082	1,259	14,271
Processing gain (−) or loss (+)	−12,793	−10,881	−11,252	−12,753	−9,939	−10,655	−11,183	−12,975	−11,792	−12,010	−10,278	−12,472	−139,433
INPUT 1972 p													
Crude petroleum:													
Domestic	288,758	268,078	288,230	278,197	292,840	289,416	303,350	303,162	289,560	291,916	282,723	297,650	3,473,880
Foreign	64,277	61,254	63,473	57,336	62,966	65,820	65,095	66,215	73,804	76,083	72,815	77,845	[1] 806,983
Total crude petroleum	353,035	329,332	351,703	335,533	355,806	355,236	368,445	369,377	363,364	367,999	355,538	375,495	4,280,863
Unfinished oils rerun (net)	+3,331	+7,842	−793	−211	−150	−1,508	+7,819	+8,303	+2,784	+6,775	+6,107	+11,219	+51,518
Total crude and unfinished oils rerun	356,366	337,174	350,910	335,322	355,656	353,728	376,264	377,680	366,148	374,774	361,645	386,714	4,332,381
Natural gas liquids:													
Liquefied petroleum gases	9,243	8,450	7,196	6,062	5,853	5,298	5,734	5,554	6,046	7,858	9,187	8,712	85,193
Natural gasoline	13,082	12,382	13,735	13,654	14,167	14,221	14,211	14,157	14,242	14,295	13,125	12,791	164,062
Plant condensate	3,478	3,573	4,210	3,535	4,493	4,337	4,677	4,810	4,750	4,795	5,197	5,335	53,190
Total natural gas liquids	25,803	24,405	25,141	23,251	24,513	23,856	24,622	24,521	25,038	26,948	27,509	26,838	302,445
Other hydrocarbons	578	614	883	808	732	808	862	1,012	757	1,006	1,167	891	10,118
OUTPUT 1972 p													
Gasoline:													
Motor gasoline [2]	190,678	173,682	183,297	174,997	186,714	187,331	204,967	204,215	198,159	202,491	193,095	199,149	2,298,775
Aviation gasoline	1,550	1,201	1,217	1,442	1,500	1,363	1,311	1,606	1,358	1,746	1,459	1,240	16,993
Total gasoline [2]	192,228	174,883	184,514	176,439	188,214	188,694	206,278	205,821	199,517	204,237	194,554	200,389	2,315,768

Jet fuel:													
Naphtha type [2]	5,696	6,596	6,921	7,020	6,873	6,825	6,416	6,793	5,833	6,077	5,742	5,773	76,565
Kerosine type	18,618	19,498	21,178	19,275	20,638	18,940	20,660	19,162	18,478	19,407	18,247	19,363	233,464
Total jet fuel [2]	24,314	26,094	28,099	26,295	27,511	25,765	27,076	25,955	24,311	25,484	23,989	25,136	310,029
Ethane (including ethylene)	820	824	821	786	737	715	783	757	723	811	718	702	9,197
Liquefied gases:													
LRG for fuel use	6,735	6,730	7,872	7,045	7,182	6,930	7,469	7,462	7,157	6,913	6,640	6,879	84,514
LRG for chemical use	2,955	2,846	2,957	3,003	3,373	3,191	3,292	3,209	2,888	2,972	2,719	3,263	36,668
Total liquefied gases	9,690	9,576	10,329	10,048	10,555	10,121	10,761	10,671	10,045	9,885	9,359	10,142	121,182
Kerosine [2]	8,628	6,658	6,966	5,859	5,098	4,897	5,571	5,757	6,648	6,294	7,772	8,879	79,027
Distillate fuel oil [2]	78,674	76,928	79,480	74,291	80,145	78,692	78,394	80,051	78,712	84,369	81,584	91,085	962,405
Residual fuel oil	28,646	27,929	25,662	22,169	20,591	19,820	20,863	20,882	21,295	23,092	26,711	34,859	292,519
Petrochemical feedstocks:													
Still gas	1,230	1,055	1,033	935	1,095	1,147	1,378	1,444	1,144	1,500	1,360	1,357	14,678
Naphtha–400°	4,646	4,390	4,380	5,005	4,723	4,866	4,685	5,041	4,303	4,575	4,957	5,456	57,027
Other	3,920	4,057	3,907	4,742	4,164	3,567	4,253	4,499	4,751	4,972	4,729	4,760	52,821
Total petrochemical feedstocks	9,796	9,502	9,320	10,682	9,982	9,580	10,316	10,984	10,198	11,047	11,046	11,573	124,026
Special naphthas [2]	2,502	2,466	2,663	2,753	2,674	2,383	2,864	2,997	2,791	2,546	2,636	2,821	32,096
Lubricants:													
Bright stock	614	584	559	463	542	511	554	530	492	563	572	556	6,540
Neutral	2,402	2,159	2,381	2,452	2,611	2,643	2,378	2,729	2,329	2,433	2,381	2,365	29,263
Other grades	2,451	2,184	2,456	2,280	2,543	2,440	2,466	2,526	2,516	2,631	2,438	2,615	29,546
Total lubricants	5,467	4,927	5,396	5,195	5,696	5,594	5,398	5,785	5,337	5,627	5,391	5,536	65,349
Wax:													
Microcrystalline	65	101	101	69	68	80	81	79	82	74	78	77	955
Crystalline—fully refined	250	265	335	232	260	241	253	278	244	273	260	276	3,167
Crystalline—other	197	128	135	170	220	173	183	170	188	162	166	134	2,026
Total wax [3]	512	494	571	471	548	494	517	527	514	509	504	487	6,148
Coke [3]	9,492	9,414	9,562	8,850	9,065	9,104	9,421	11,196	10,558	11,094	10,739	11,270	119,765
Asphalt [3]	8,150	8,125	9,954	11,373	14,926	15,992	17,051	17,492	16,632	15,094	11,392	9,113	155,294
Road oil	288	356	635	613	768	1,139	1,151	1,151	836	595	273	138	7,943
Still gas for fuel	13,814	12,700	13,514	13,375	13,977	14,381	15,171	15,589	14,642	14,573	14,308	14,949	170,993
Miscellaneous products [2]	1,227	1,145	1,256	1,159	1,221	1,133	1,332	1,424	1,469	1,288	1,388	1,322	15,364
Processing gain (−) or loss (+)	−11,501	−9,828	−11,808	−10,977	−10,807	−10,112	−11,199	−13,826	−12,285	−13,817	−12,043	−13,958	−142,161

[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.
[3] Conversion factors: 280 pounds of wax to the barrel; 5.0 barrels of coke to the short ton; 5.5 barrels of asphalt to the short ton.

Table 36.—Input and output at refineries

(Thousand

Item	PAD district I: East Coast	PAD district I: Appalachian No. 1	PAD district I: Total	PAD district II: Appalachian No. 2	PAD district II: Ind., Ill., etc.	PAD district II: Minn., Wis., etc.	PAD district II: Okla., Kans., etc.	PAD district II: Total
INPUT 1971								
Crude petroleum:								
Domestic	217,562	19,325	236,887	19,538	671,712	23,195	327,016	1,041,461
Foreign	213,316	35,507	248,823	457	[1] 78,081	56,172	2,866	137,576
Total crude petroleum	430,878	54,832	485,710	19,995	749,793	79,367	329,882	1,179,037
Unfinished oils rerun (net)	+56,004	+97	+56,101	+63	−1,774	+65	−218	−1,864
Total crude and unfinished oils rerun	486,882	54,929	541,811	20,058	748,019	79,432	329,664	1,177,173
Natural gas liquids:								
Liquefied petroleum gases	954	24	978	--	11,230	3,179	10,222	24,631
Natural gasoline	2,035	6	2,041	--	7,231	977	11,508	19,716
Plant condensate	662	562	1,224	145	3,396	3,211	--	6,752
Total natural gas liquids	3,651	592	4,243	145	21,857	7,367	21,730	51,099
Other hydrocarbons	--	--	--	--	227	--	198	425
OUTPUT 1971								
Gasoline:								
Motor gasoline [2]	230,558	23,369	253,927	10,296	412,635	44,243	196,090	663,264
Aviation gasoline	471	--	471	--	1,874	--	478	2,352
Total gasoline [2]	231,029	23,369	254,398	10,296	414,509	44,243	196,568	665,616
Jet fuel:								
Naphtha type [2]	2,167	735	2,902	--	7,836	1,234	8,196	17,266
Kerosine type	11,409	740	12,149	--	34,289	1,496	10,962	46,747
Total jet fuel [2]	13,576	1,475	15,051	--	42,125	2,730	19,158	64,013
Ethane (including ethylene)	217	--	217	--	--	--	612	612
Liquefied gases:								
LRG for fuel use	11,578	1,212	12,790	367	14,097	1,460	7,524	23,448
LRG for chemical use	5,088	--	5,088	--	2,630	12	1,017	3,659
Total liquefied gases	16,666	1,212	17,878	367	16,727	1,472	8,541	27,107
Kerosine [2]	8,683	1,333	10,016	791	14,959	1,326	2,987	20,063
Distillate fuel oil [2]	123,809	12,995	136,804	5,520	157,394	20,673	77,598	261,185
Residual fuel oil	31,566	5,559	37,125	1,402	45,728	6,435	5,325	58,890
Petrochemical feedstocks:								
Still gas	1,355	18	1,373	--	1,769	118	61	1,948
Naphtha—400°	3,056	--	3,056	--	3,926	--	1,915	5,841
Other	103	456	559	--	2,307	14	428	2,749
Total petrochemical feedstocks	4,514	474	4,988	--	8,002	132	2,404	10,538
Special naphthas [2]	532	345	877	264	3,373	--	1,375	5,012
Bright stock	535	1,303	1,838	--	654	--	800	1,454
Neutral	3,786	2,235	6,021	8	2,644	--	3,187	5,839
Other grades	3,902	545	4,447	--	2,197	--	1,475	3,672
Total lubricants	8,223	4,083	12,306	8	5,495	--	5,462	10,965
Wax:								
Microcrystalline	371	200	571	--	127	--	235	362
Crystalline-fully refined	1,083	95	1,178	14	248	--	225	487
Crystalline-other	546	328	874	--	153	--	94	247
Total wax [3]	2,000	623	2,623	14	528	--	554	1,096
Coke [3]	11,785	150	11,935	--	18,045	3,104	9,900	31,049
Asphalt [3]	31,414	1,667	33,081	1,272	32,784	6,044	15,916	56,016
Road oil	28	662	690	--	3,383	216	935	4,534
Still gas for fuel	18,506	1,993	20,499	656	30,480	2,187	11,895	45,218
Miscellaneous products [2]	1,961	128	2,089	18	1,468	133	1,004	2,623
Processing gain (−) or loss (+)	−13,976	−547	−14,523	−405	−24,897	−1,896	−8,642	−35,840

See footnotes at end of table.

in the United States by district

barrels)

PAD district III						PAD district IV	PAD district V	
Tex. Inland	Tex. Gulf	La. Gulf	Ark., La. Inland, etc.	N. Mex.	Total	Other Rocky Mt.	West Coast	United States
146,330	904,134	499,694	54,073	15,480	1,619,711	131,307	452,177	3,481,543
--	16,963	2,741	--	--	19,704	16,576	183,587	[1] 606,266
146,330	921,097	502,435	54,073	15,480	1,639,415	147,883	635,764	4,087,809
−1,302	−20,108	−237	+527	+62	−21,058	+137	+10,292	+43,608
145,028	900,989	502,198	54,600	15,542	1,618,357	148,020	646,056	4,131,417
8,397	17,416	15,205	753	757	42,528	3,306	8,252	79,695
15,569	88,498	25,929	797	379	131,172	1,619	11,674	166,222
--	17,301	2,468	2,421	--	22,190	4,718	4,136	39,020
23,966	123,215	43,602	3,971	1,136	195,890	9,643	24,062	284,937
327	227	2,004	--	--	2,558	204	2,887	6,074
95,814	494,765	263,308	24,378	8,594	886,859	77,577	297,466	2,179,093
1,719	6,117	2,896	--	--	10,732	474	4,428	18,457
97,533	500,882	266,204	24,378	8,594	897,591	78,051	301,894	2,197,550
8,388	13,156	10,070	1,755	1,980	35,349	3,929	25,871	85,317
8,474	48,280	40,297	12	52	97,115	4,413	58,924	219,348
16,862	61,436	50,367	1,767	2,032	132,464	8,342	84,795	304,665
97	4,395	3,334	--	--	7,826	--	611	9,266
3,436	19,283	14,313	1,076	520	38,628	2,347	11,435	88,648
167	12,535	5,992	318	--	19,012	26	4,519	32,304
3,603	31,818	20,305	1,394	520	57,640	2,373	15,954	120,952
1,495	33,450	16,448	885	94	52,372	2,104	1,701	86,256
26,251	224,300	121,334	13,767	3,091	388,743	38,054	85,941	910,727
3,020	37,494	16,585	3,246	549	60,894	9,886	107,889	274,684
8	7,796	--	--	--	7,804	145	4,888	16,158
1,487	37,125	1,443	--	--	40,055	--	5,144	54,096
2,871	13,392	19,444	129	--	35,836	227	1,323	40,694
4,366	58,313	20,887	129	--	83,695	372	11,355	110,948
1,057	14,367	404	1,126	1	16,955	205	5,206	28,255
--	1,767	685	--	--	2,452	45	1,318	7,107
--	8,297	5,971	773	--	15,041	204	2,206	29,311
87	16,584	1,221	1,185	--	19,077	163	1,696	29,055
87	26,648	7,877	1,958	--	36,570	412	5,220	65,473
75	176	49	--	--	300	11	--	1,244
--	553	396	--	--	949	59	399	3,072
--	795	492	--	--	1,287	22	193	2,623
75	1,524	937	--	--	2,536	92	592	6,939
2,405	20,342	13,041	2,065	111	37,964	3,046	25,120	109,114
6,757	9,556	14,548	7,207	932	39,000	9,914	19,028	157,039
180	7	--	--	--	187	1,878	1,466	8,755
4,959	35,530	17,495	1,929	547	60,460	4,963	25,827	156,967
2,138	4,317	711	18	--	7,184	88	2,287	14,271
−1,564	−39,948	−22,673	−1,298	+207	−65,276	−1,913	−21,881	−139,433

Table 36.—Input and output at refineries

Thousand

Item	PAD district I			PAD district II				
	East Coast	Appalachian No. 1	Total	Appalachian No. 2	Ind., Ill., etc.	Minn., Wis., etc.	Okla., Kans., etc.	Total
INPUT 1972 p								
Crude petroleum:								
Domestic	108,520	18,588	127,108	17,216	677,852	22,508	325,439	1,043,015
Foreign	315,266	40,100	355,366	2,392	[1] 100,952	60,824	4,565	168,733
Total crude petroleum	423,786	58,688	482,474	19,608	778,804	83,332	330,004	1,211,748
Unfinished oils rerun (net)	+57,479	+182	+57,661	+30	+40	−36	+1,228	+1,262
Total crude and unfinished oils rerun	481,265	58,870	540,135	19,638	778,844	83,296	331,232	1,213,010
Natural gas liquids:								
Liquefied petroleum gases	251	90	341	--	11,750	3,415	11,107	26,272
Natural gasoline	889	9	898	--	7,162	1,603	11,417	20,182
Plant condensate	487	960	1,447	475	13,497	6,618	--	20,590
Total natural gas liquids	1,627	1,059	2,686	475	32,409	11,636	22,524	67,044
Other hydrocarbons	--	--	--	--	264	--	275	539
OUTPUT 1972 p								
Gasoline:								
Motor gasoline [2]	235,576	25,127	260,703	10,060	438,817	48,550	199,940	697,367
Aviation gasoline	355	--	355	--	1,670	--	539	2,209
Total gasoline [2]	235,931	25,127	261,058	10,060	440,487	48,550	200,479	699,576
Jet fuel:								
Naphtha type [2]	1,454	650	2,104	--	7,552	1,446	6,686	15,684
Kerosine type	10,545	678	11,223	--	35,421	1,397	10,404	47,222
Total jet fuel [2]	11,999	1,328	13,327	--	42,973	2,843	17,090	62,906
Ethane (including ethylene)	--	--	--	--	--	--	590	590
Liquefied gases:								
For fuel use	10,991	1,432	12,423	324	14,400	1,284	7,109	23,117
For chemical use	5,497	--	5,497	--	2,634	222	1,170	4,026
Total liquefied gases	16,488	1,432	17,920	324	17,034	1,506	8,279	27,143
Kerosine [2]	6,190	1,614	7,804	781	15,041	1,339	2,932	20,093
Distillate fuel oil [2]	118,572	13,916	132,488	5,038	168,356	22,781	79,897	276,072
Residual fuel oil	30,873	6,709	37,582	1,730	50,219	7,016	6,883	65,848
Petrochemical feedstocks:								
Still gas	945	74	1,019	--	2,610	--	2,070	4,680
Naphtha—400°	5,392	--	5,392	--	4,241	--	2,147	6,388
Other	66	665	731	--	2,293	--	451	2,744
Total petrochemical feedstocks	6,403	739	7,142	--	9,144	--	4,668	13,812
Special naphthas [2]	200	339	539	282	3,755	--	1,330	5,367
Lubricants:								
Bright stock	356	1,301	1,657	--	498	--	654	1,152
Neutral	2,903	2,439	5,342	12	3,260	--	3,180	6,452
Other grades	3,606	389	3,995	--	1,498	--	1,418	2,916
Total lubricants	6,865	4,129	10,994	12	5,256	--	5,252	10,520
Wax:								
Microcrystalline	171	237	408	--	9	--	265	274
Crystalline—fully refined	828	148	976	--	205	--	246	451
Crystalline—other	261	421	682	--	192	--	104	296
Total wax [3]	1,260	806	2,066	--	406	--	615	1,021
Coke [3]	13,187	236	13,423	129	20,229	3,405	10,404	34,167
Asphalt [3]	28,087	1,620	29,707	1,447	31,487	6,340	14,578	53,852
Road oil	49	619	668	--	2,735	207	938	3,880
Still gas for fuel	19,403	2,127	21,530	697	31,335	1,423	10,609	44,064
Miscellaneous products [2]	2,192	171	2,363	41	1,444	133	1,312	2,930
Processing gain (−) or loss (+)	−14,807	−983	−15,790	−428	−28,384	−611	−11,825	−41,248

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.
[3] Conversion factors: 280 pounds of wax to the barrel; 5.0 barrels of coke to the short ton; 5.5 barrels of asphalt to the short ton.

in the United States by district—Continued

barrels)

PAD district III						PAD district IV	PAD district V	
Tex. Inland	Tex. Gulf	La. Gulf	Ark., La. Inland, etc.	N. Mex.	Total	Other Rocky Mt.	West Coast	United States
151,737	937,758	581,455	48,072	16,261	1,735,283	131,990	436,484	3,473,880
--	23,465	4,194	--	--	27,659	13,425	241,800	[1] 806,983
151,737	961,223	585,649	48,072	16,261	1,762,942	145,415	678,284	4,280,863
−72	−23,761	+2,639	+738	−9	−20,465	−940	+14,000	+51,518
151,665	937,462	588,288	48,810	16,252	1,742,477	144,475	692,284	4,332,381
8,764	18,418	19,037	1,168	672	48,059	3,272	7,249	85,193
16,396	89,005	24,203	1,034	555	131,193	1,603	10,186	164,062
24	12,121	2,026	2,076	--	16,247	11,376	3,530	53,190
25,184	119,544	45,266	4,278	1,227	195,499	16,251	20,965	302,445
233	192	2,898	53	--	3,376	131	6,072	10,118
101,350	500,833	308,750	20,370	9,041	940,344	80,432	319,929	2,298,775
2,053	5,279	2,648	--	--	9,980	453	3,996	16,993
103,403	506,112	311,398	20,370	9,041	950,324	80,885	323,925	2,315,768
5,084	12,487	7,692	1,553	2,073	28,889	4,079	25,809	76,565
9,040	53,702	47,540	8	50	110,340	4,513	60,166	233,464
14,124	66,189	55,232	1,561	2,123	139,229	8,592	85,975	310,029
104	4,802	3,147	--	--	8,053	3	551	9,197
3,317	17,195	13,175	549	455	34,691	2,193	12,090	84,514
261	13,750	8,236	399	4	22,650	55	4,440	36,668
3,578	30,945	21,411	948	459	57,341	2,248	16,530	121,182
1,296	28,865	16,754	744	103	47,762	1,844	1,524	79,027
28,535	233,079	147,767	11,498	3,299	424,178	38,024	91,643	962,405
3,608	37,682	18,695	4,428	634	65,047	9,152	114,890	292,519
274	7,647	79	5	12	8,017	226	736	14,678
1,461	38,732	337	--	--	40,530	--	4,717	57,027
3,469	20,063	21,882	225	--	45,639	79	3,128	52,321
5,204	66,442	22,298	230	12	94,186	305	8,581	124,026
1,219	18,014	307	1,269	--	20,809	205	5,176	32,096
--	1,512	751	--	--	2,263	57	1,411	6,540
--	8,440	5,645	887	--	14,972	195	2,302	29,263
98	18,024	1,298	1,169	--	20,589	143	1,903	29,546
98	27,976	7,694	2,056	--	37,824	395	5,616	65,349
69	141	53	--	--	263	10	--	955
--	611	509	--	--	1,120	63	557	3,167
--	834	64	--	--	898	27	123	2,026
69	1,586	626	--	--	2,281	100	680	6,148
2,811	21,687	14,342	958	176	39,974	3,559	28,642	119,765
7,107	8,533	15,660	8,156	1,019	40,475	10,364	20,896	155,294
69	33	--	--	--	102	1,144	2,149	7,943
5,581	37,219	22,426	1,482	548	67,256	5,424	32,719	170,993
2,249	4,216	1,248	92	--	7,805	77	2,189	15,364
−1,973	−36,182	−22,553	−651	+65	−61,294	−1,464	−22,365	−142,161

Table 37.—Percentage yields of refined petroleum products from crude oil in the United States [1]

Finished products	1968	1969	1970	1971	1972 p
Gasoline	43.9	44.8	45.3	46.2	46.2
Jet fuel	8.3	8.2	7.5	7.4	7.2
Ethane (including ethylene)	(2)	.2	.2	.2	.2
Liquefied gases	3.1	2.9	3.0	2.9	2.8
Kerosine	2.7	2.6	2.3	2.1	1.8
Distillate fuel oil	22.1	21.7	22.4	22.0	22.2
Residual fuel oil	7.2	6.8	6.4	6.6	6.8
Petrochemical feedstocks	2.5	2.5	2.5	2.7	2.9
Special naphthas	.7	.7	.8	.7	.7
Lubricants	1.7	1.7	1.6	1.6	1.5
Wax	.2	.2	.2	.2	.1
Coke	2.5	2.6	2.7	2.6	2.8
Asphalt	3.6	3.5	3.6	3.8	3.6
Road oil	.1	.2	.3	.2	.2
Still gas	4.0	4.1	4.1	3.8	3.9
Miscellaneous	.4	.4	.3	.4	.4
Shortage	−3.0	−3.1	−3.2	−3.4	−3.3
Total	100.0	100.0	100.0	100.0	100.0

p Preliminary.
1 Other unfinished oils added to crude in computing yields.
2 Included with liquefied gases.

Table 38.—Salient statistics of motor gasoline in the United States, by month and district

(Thousand barrels)

	1971						1972 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	183,378	479	2,158	22	232,079	163,169	190,678	356	1,574	36	239,912	172,012
February	164,880	438	1,309	26	245,310	153,370	173,682	344	1,903	14	250,236	165,591
March	178,914	465	1,991	19	245,659	181,002	183,297	356	2,076	28	237,177	198,760
April	168,447	433	1,893	141	230,349	185,942	174,997	339	1,569	28	225,552	188,502
May	172,357	456	1,566	43	221,714	182,971	186,714	344	2,287	16	215,089	199,792
June	179,508	406	1,541	24	209,595	193,550	187,331	364	2,244	15	200,353	204,660
July	190,748	429	1,652	21	203,010	199,393	204,967	395	2,136	18	200,975	206,858
August	194,323	429	1,676	23	204,225	195,190	204,215	366	2,512	13	192,967	215,088
September	183,649	381	1,718	38	207,885	182,050	198,159	329	2,084	38	199,927	193,574
October	186,145	422	1,115	14	208,525	187,028	202,491	328	2,195	177	207,915	196,849
November	181,268	303	2,304	16	208,959	183,425	193,095	327	2,080	22	209,032	194,363
December	195,476	382	2,735	23	219,352	188,177	199,149	334	2,127	20	212,894	197,728
Total	2,179,093	5,023	21,658	410	219,352	2,195,267	2,298,775	4,182	24,787	425	212,894	2,333,777
By refining district:												
East Coast	230,558	--	21,425	6	55,296	745,076	235,576	--	24,609	6	50,587	790,864
Appalachian No. 1	23,369	--			6,097		25,127				5,155	
Appalachian No. 2	10,296	--			3,385		10,060	--			3,805	
Indiana, Illinois, Kentucky, etc.	412,635	--	--	3	35,702	759,172	438,817	--	43	3	36,835	807,406
Minnesota, Wisconsin, etc.	44,243	--			7,515		48,550	--			7,572	
Oklahoma, Kansas, etc.	196,090	1			18,675		199,940	--			17,082	
Texas Inland	95,814	829			9,254		101,350	727			9,356	
Texas Gulf Coast	494,765	170			29,751		500,833	205			26,631	
Louisiana Gulf Coast	263,308	1,658	--	157	13,642	301,092	308,750	1,638	--	265	15,035	323,150
Arkansas, Louisiana Inland, etc.	24,378	2,365			7,757		20,370	1,612			8,227	
New Mexico	8,594	--			856		9,041	--			918	
Rocky Mountain	77,577	--	--	--	6,443	72,596	80,432	--	--	--	5,737	68,576
West Coast	297,466	--	233	244	24,979	317,331	319,929	--	135	151	25,954	343,781
Total	2,179,093	5,023	21,658	410	219,352	2,195,267	2,298,775	4,182	24,787	425	212,894	2,333,777

p Preliminary.

[1] Includes stocks of gasoline at refineries, bulk terminals and pipelines, and gas processing plants.

Table 39.—Production (refinery output) and consumption of gasoline (excluding naphtha) in the United States, by State

(Thousand barrels)

State	1970		1971		1972 p	
	Production	Consumption [1]	Production	Consumption [1]	Production	Consumption [1]
Alabama	495	38,155	640	40,336	896	43,301
Alaska	--	2,430	140	2,559	446	2,834
Arizona	--	22,649	--	24,008	--	26,323
Arkansas	15,257	23,019	13,580	24,565	7,594	26,773
California	[2] 297,236	219,693	[2] 301,754	227,060	[2] 323,479	241,154
Colorado	7,116	26,523	8,018	28,385	7,766	30,964
Connecticut	--	29,026	--	30,238	--	31,810
Delaware	(3)	6,305	(3)	6,485	(3)	6,970
District of Columbia	--	5,705	--	5,811	--	5,792
Florida	--	78,761	--	84,671	--	93,638
Georgia	--	55,206	--	59,182	--	64,012
Hawaii	(2)	5,439	(2)	5,908	(2)	6,363
Idaho	--	9,791	--	10,282	--	11,027
Illinois	152,576	105,323	168,937	109,818	176,948	115,526
Indiana	97,576	60,045	93,782	62,267	99,981	65,881
Iowa	--	36,350	--	38,523	--	39,853
Kansas	[4] 98,674	32,816	[4] 99,525	32,566	[4] 101,947	33,436
Kentucky	[5] 26,837	34,373	[5] 30,420	36,693	[5] 30,675	38,893
Louisiana	224,772	35,763	236,883	37,204	273,332	40,572
Maine	--	11,220	--	11,801	--	12,507
Maryland	--	37,626	--	39,874	--	42,523
Massachusetts	--	49,891	--	51,611	--	54,531
Michigan	26,804	99,619	27,399	102,688	27,047	108,625
Minnesota	25,788	45,412	29,552	47,808	33,772	50,236
Mississippi	34,402	24,952	39,479	26,352	49,946	28,675
Missouri	(4)	57,016	(4)	60,653	(4)	63,522
Montana	22,233	10,125	23,922	10,598	27,053	10,899
Nebraska	(4)	20,225	(4)	21,202	(4)	21,965
Nevada	--	7,693	--	8,141	--	8,909
New Hampshire	--	8,295	--	8,844	--	9,365
New Jersey	84,232	67,510	88,276	69,758	92,896	75,928
New Mexico	8,141	13,431	8,594	14,866	9,041	15,844
New York	14,396	149,777	15,281	156,761	16,950	161,557
North Carolina	--	57,650	--	60,702	--	65,892
North Dakota	[6] 14,733	9,060	[6] 14,691	9,311	[6] 14,778	10,231
Ohio	103,844	109,519	104,267	112,344	115,896	120,605
Oklahoma	94,936	37,490	97,043	38,232	98,532	39,266
Oregon	--	25,336	--	26,722	--	28,541
Pennsylvania	[3] 135,396	103,472	[3] 141,943	107,120	[3] 141,053	117,867
Rhode Island	--	8,240	--	9,512	--	9,841
South Carolina	--	29,066	--	31,511	--	35,186
South Dakota	--	10,143	--	10,594	--	11,203
Tennessee	(5)	43,259	(5)	46,378	(5)	50,824
Texas	562,122	152,226	598,415	159,997	609,515	168,899
Utah	22,158	14,372	22,678	15,391	21,454	16,405
Vermont	--	5,115	--	5,413	--	5,798
Virginia	(7)	50,862	(7)	53,992	(7)	57,365
Washington	(2)	36,721	(2)	37,671	(2)	39,243
West Virginia	[7] 7,571	16,526	[7] 8,898	15,623	[7] 10,159	17,543
Wisconsin	(6)	46,386	(6)	48,113	(6)	51,238
Wyoming	22,616	6,085	23,433	6,322	24,612	6,879
Total	2,099,911	2,191,692	2,197,550	2,292,466	2,315,768	2,443,034

p Preliminary.
[1] American Petroleum Institute.
[2] Washington and Hawaii included with California.
[3] Delaware included with Pennsylvania.
[4] Nebraska and Missouri included with Kansas.
[5] Tennessee included with Kentucky.
[6] Wisconsin included with North Dakota.
[7] Virginia included with West Virginia.

Table 40.—Salient statistics of aviation gasoline in the United States, by month and refining district

(Thousand barrels)

	1971				1972 p			
	Production	Exports	Stocks (end of period)	Domestic demand	Production	Exports	Stocks (end of period)	Domestic demand
By month:								
January	1,387	114	4,943	1,423	1,550	104	4,679	1,186
February	1,686	226	5,206	1,197	1,201	37	4,573	1,270
March	1,372	65	4,906	1,607	1,217	120	4,036	1,634
April	1,509	79	4,641	1,695	1,442	26	3,994	1,458
May	1,467	63	4,518	1,527	1,500	35	4,080	1,379
June	1,457	72	4,376	1,527	1,363	64	3,930	1,449
July	1,486	109	4,177	1,576	1,311	60	3,696	1,485
August	1,853	66	4,149	1,815	1,606	19	3,784	1,499
September	2,093	236	4,430	1,576	1,358	22	3,769	1,351
October	1,587	35	4,372	1,610	1,746	14	3,825	1,676
November	1,490	76	4,604	1,182	1,459	15	4,134	1,135
December	1,070	98	4,419	1,157	1,240	13	4,255	1,106
Total	18,457	1,239	4,419	17,892	16,993	529	4,255	16,628
By refining district:								
East Coast	471		619		355		566	
Appalachian No. 1	--	46	49	5,253	--	47	46	4,666
Appalachian No. 2	--		1		--		1	
Illinois, Indiana, Kentucky, etc.	1,874		548		1,670		811	
Minnesota, Wisconsin, North Dakota	--	76	170	4,295	--	18	127	3,870
Oklahoma, Kansas, etc.	478		259		539		220	
Texas Inland	1,719		264		2,053		333	
Texas Gulf Coast	6,117		927		5,279		843	
Louisiana Gulf Coast	2,896	1,009	545	3,077	2,648		429	
Arkansas, Louisiana Inland, etc.	--		30		--	373	5	3,376
New Mexico	--		3		--		2	
Rocky Mountain	474	--	68	679	453	1	56	688
West Coast	4,428	108	936	4,570	3,996	90	816	4,028
Total	18,457	1,239	4,419	17,892	16,993	529	4,255	16,628

p Preliminary.

Table 41.—Shipments of aviation fuels

(Thousand barrels)

Product and use	Shipments to PAD districts I	II	III	IV	V	U.S. total
1971						
Aviation gasoline:						
For commercial use:						
Airlines	376	97	118	25	146	762
Factory	34	29	18	--	14	95
General aviation	2,317	3,105	1,578	399	2,049	9,448
Total	2,727	3,231	1,714	424	2,209	10,305
For military use	2,560	1,065	1,350	258	2,356	7,589
Jet fuel:						
For commercial use:						
Kerosine type:						
Airlines	r 91,113	53,334	19,558	6,001	r 69,135	r 239,141
Factory	349	211	131	--	528	1,219
General aviation	3,265	2,457	1,340	371	845	8,278
Total	r 94,727	56,002	21,029	6,372	r 70,508	r 248,638
Naphtha type:						
Airlines	2,906	295	681	--	1,583	5,465
Factory	840	148	23	--	340	1,351
General aviation	71	4	10	--	131	216
Total	3,817	447	714	--	2,054	7,032
Total for commercial use	r 98,544	56,449	21,743	6,372	r 72,562	r 255,670
For military use:						
JP-4	[1] 16,965	17,377	13,924	2,197	[1] 28,030	78,493
JP-5	10,160	1,687	1,177	31	9,924	22,979
Other	765	17	648	363	457	2,250
Total [1]	27,890	19,081	15,749	2,591	38,411	103,722
1972						
Aviation gasoline:						
For commercial use:						
Airlines	385	225	149	28	138	925
Factory	46	39	15	1	51	152
General aviation	2,412	2,839	1,598	457	2,324	9,630
Total	2,843	3,103	1,762	486	2,513	10,707
For military use	2,207	794	1,002	190	1,733	5,926
Jet fuel:						
For commercial use:						
Kerosine type:						
Airlines	92,851	55,057	18,916	6,934	73,185	246,943
Factory	626	554	290	--	645	2,115
General aviation	6,877	2,768	1,675	388	1,052	12,760
Total [2]	100,354	58,379	20,881	7,322	74,882	261,818
Naphtha type:						
Airlines	1,154	7	--	--	3,308	4,469
Factory	1,015	166	20	--	20	1,221
General aviation	493	115	22	2	257	889
Total	2,662	288	42	2	3,585	6,579
Total for commercial use [2]	103,016	58,667	20,923	7,324	78,467	268,397
For miltiary use:						
JP-4	[3] 16,935	16,786	11,183	2,650	[3] 25,153	72,707
JP-5	9,197	249	1,485	--	9,816	20,747
Other	888	12	848	315	568	2,631
Total [3]	27,020	17,047	13,516	2,965	35,537	96,085

r Revised.
[1] Excludes direct imports by the military into PAD district I, 7,300,000 barrels; PAD district V, 1,946,000 barrels.
[2] Excludes shipments for nonaviation use, by PAD district I, 6,891,000 barrels; PAD district II, 1,464,000 barrels; PAD district III, 2,000 barrels; PAD district IV, 55,000 barrels; PAD district V, 409,000 barrels.
[3] Excludes direct imports by the military into PAD district I, 6,939,000 barrels; PAD district V, 2,129,000 barrels.

Table 42.—Salient statistics of kerosine in the United States, by month and district

(Thousand barrels unless otherwise stated)

	1971							1972 p						
	Production at refineries	Yield (%)	Production at gas processing plants	Imports	Exports	Total stocks (end of period)	Domestic demand	Production at refineries	Yield (%)	Production at gas processing plants	Imports	Exports	Total stocks (end of period)	Domestic demand
By month:														
January	9,352	2.6	110	1	24	23,921	13,366	8,628	2.4	97	1	8	21,339	11,817
February	8,332	2.6	100	--	20	19,662	12,671	6,658	2.0	93	24	3	17,408	10,703
March	8,228	2.4	116	1	15	19,231	8,761	6,966	2.0	96	--	8	15,693	8,769
April	6,577	2.0	94	--	24	19,539	6,339	5,859	1.7	80	1	4	16,363	5,266
May	5,839	1.7	113	--	5	21,610	3,876	5,098	1.4	106	1	4	17,132	4,432
June	6,443	1.9	96	--	27	23,602	4,520	4,897	1.4	97	--	11	18,640	3,475
July	7,082	2.0	111	--	25	26,392	4,378	5,571	1.5	109	41	19	21,481	2,861
August	5,993	1.7	124	--	4	28,030	4,475	5,757	1.5	97	28	8	22,060	5,295
September	5,496	1.6	107	48	7	27,806	5,868	6,648	1.8	73	83	2	22,917	5,945
October	7,095	2.1	105	23	11	28,218	6,800	6,294	1.7	71	45	5	21,956	7,366
November	7,011	2.1	74	9	11	26,765	8,536	7,772	2.1	70	116	10	21,351	8,553
December	8,808	2.4	93	107	8	24,438	11,327	8,879	2.3	74	186	7	19,111	11,372
Total	86,256	2.1	1,243	189	181	24,438	90,917	79,027	1.8	1,063	526	89	19,111	85,854
By refining districts:														
East Coast	8,683	1.8	--	187	11	9,983	47,411	6,190	1.3	--	524	9	7,231	43,643
Appalachian No. 1	1,333	2.4	--			693		1,614	2.7	--			476	
Appalachian No. 2	791	3.9	--			497		781	4.0	--			529	
Indiana, Illinois, Kentucky, etc.	14,959	2.0	--	2	5	4,435	28,028	15,041	1.9	--	2	1	3,885	25,002
Minnesota, Wisconsin, etc.	1,326	1.7	--			1,084		1,339	1.6	--			970	
Oklahoma, Kansas, etc.	2,987	.9	--			1,016		2,932	.9	--			646	
Texas Inland	1,495	1.0	330			266		1,296	.9	368			195	
Texas Gulf Coast	33,450	3.7	36			2,381		28,865	3.1	33			2,260	
Louisiana Gulf Coast	16,448	3.3	281			2,287		16,754	2.9	227			1,505	
Arkansas, Louisiana Inland, etc.	885	1.6	560	--	40	846	11,852	744	1.5	393	--	66	718	13,552
New Mexico	94	.6	36			13		103	.6	42			28	
Rocky Mountain	2,104	1.4	--	--	--	547	1,905	1,844	1.3	—	--	--	297	2,062
West Coast	1,701	.3	--	--	25	390	1,721	1,524	.2	--	--	13	371	1,595
Total	86,256	2.1	1,243	189	181	24,438	90,917	79,027	1.8	1,063	526	89	19,111	85,854

p Preliminary.

Table 43.—Salient statistics of distillate fuel oil in the United States, by month and refining district

(Thousand barrels unless otherwise stated)

	1971								1972 p							
	Production at refineries	Yield (%)	Production at gas processing plants	Crude used directly as distillate [1]	Imports	Exports	Total stocks, end of period	Domestic demand	Production at refineries	Yield (%)	Production at gas processing plants	Crude used directly as distillate [1]	Imports	Exports	Total stocks, end of period	Domestic demand
By month:																
January	80,811	22.9	119	52	6,484	272	158,740	123,725	78,674	22.1	108	72	6,125	96	160,073	115,432
February	72,178	22.6	114	51	5,200	241	128,706	107,336	76,928	22.8	98	60	5,931	138	122,194	120,758
March	77,898	22.4	129	67	5,585	378	112,872	99,135	79,480	22.6	107	46	7,792	94	101,765	107,760
April	76,551	23.1	127	125	3,237	169	113,693	79,050	74,291	22.2	107	68	5,662	236	98,324	83,333
May	74,935	22.4	129	124	2,874	248	125,815	65,692	80,145	22.5	107	81	4,086	52	112,926	69,765
June	76,679	22.2	124	166	3,509	410	145,790	60,093	78,692	22.2	112	88	2,883	107	128,779	65,815
July	77,671	21.7	111	166	3,327	316	172,373	54,376	54,394	20.8	101	91	3,119	62	155,593	54,829
August	77,831	21.6	103	184	2,841	259	196,973	56,100	80,051	21.2	104	92	2,862	18	174,702	63,982
September	71,215	21.0	84	159	2,963	94	210,136	61,164	78,712	21.5	99	89	2,963	119	190,289	66,157
October	74,644	21.6	113	142	3,679	135	222,969	65,610	84,369	22.5	95	66	6,299	14	195,570	85,534
November	72,078	21.4	101	131	5,098	161	214,780	85,436	81,584	22.6	86	105	6,820	46	182,619	101,500
December	78,236	21.7	116	181	10,986	78	[2] 190,622	113,599	91,085	23.6	96	86	11,849	232	[2] 154,319	131,184
Total	910,727	22.0	1,370	1,548	55,783	2,761	[2] 190,622	971,316	962,405	22.2	1,220	944	66,391	1,214	[2] 154,319	1,066,049
By refining district:																
East Coast	123,809	25.4	--	--	53,373	34	73,968	483,456	118,572	24.6	--		64,244	95	61,513	511,233
Appalachian No. 1	12,995	23.7	--				3,882		13,916	23.6	--				3,297	
Appalachian No. 2	5,520	27.5	--				2,968		5,038	25.7	--				2,921	
Indiana, Illinois, Kentucky, etc	157,394	21.0	--	499	258	388	29,851	286,165	168,356	21.6	--	329	473	27	22,096	323,243
Minnesota, Wisconisn, etc	20,673	26.0	--				9,516		22,781	27.4	--				6,388	
Oklahoma, Kansas, etc	77,598	23.5	--				14,517		79,897	24.1	--				11,034	
Texas Inland	26,251	18.1	127				2,317		28,535	18.8	111				2,347	
Texas Gulf Coast	224,300	24.9	98				21,765		233,079	24.9	93				19,105	
Louisiana Gulf Coast	121,334	24.2	447	191	1,079	839	11,190	75,212	147,767	25.1	481	191	1,191	214	6,376	101,644
Arkansas, Louisiana, Inland, etc	13,767	25.2	698				5,641		11,498	23.5	535				3,275	
New Mexico	3,091	19.9	--				198		3,299	20.3	--				281	
Rocky Mountain	38,054	25.7	--	69	--	--	2,808	29,892	38,024	26.3	--	69	--	--	2,558	30,445
West Coast	85,941	13.3	--	789	1,073	1,500	12,001	96,591	91,643	13.2	--	355	483	878	12,128	99,484
Total	910,727	22.0	1,370	1,548	55,783	2,761	[2] 190,622	971,316	962,405	22.2	1,220	944	66,391	1,214	[2] 154,319	1,066,049

p Preliminary.

[1] Figures represent crude oil used as fuel on pipelines which is considered part of the demand for distillate.

[2] Includes No. 4 fuel oil in thousands of barrels: PAD district I, 1971, 4,021; 1972, 2,996; PAD district II, 1971, 328; 1972, 336; PAD district III, 1971, 654; 1972, 223; PAD district IV, 1971, 6; 1972, 12; PAD district V, 1971, 151; 1972, 156.

Table 44.—Salient statistics of residual fuel oil in the United States, by month and refining districts

(Thousand barrels unless otherwise stated)

	1971							1972 p						
	Production	Yield (%)	Crude used directly as residual [1]	Imports	Exports	Stocks (end of period)	Domestic demand	Production	Yield (%)	Crude used directly as residual [1]	Imports	Exports	Stocks (end of period)	Domestic demand
By month:														
January	31,321	8.9	328	55,193	494	53,878	86,464	28,646	8.0	277	58,658	547	59,440	87,275
February	27,099	8.5	371	49,635	1,355	48,900	80,728	27,929	8.3	262	55,761	548	50,891	91,953
March	26,533	7.6	479	57,598	1,521	49,425	82,564	25,662	7.3	252	59,718	1,806	51,566	83,151
April	22,238	6.7	337	47,229	1,749	50,623	66,857	22,169	6.6	243	50,265	1,507	49,425	73,311
May	18,978	5.7	325	46,634	1,167	55,371	60,022	20,591	5.8	255	48,770	567	53,035	65,439
June	20,042	5.8	376	43,540	1,090	58,735	59,504	19,820	5.6	275	49,455	603	56,109	65,873
July	19,964	5.6	367	45,231	991	63,716	59,590	20,863	5.5	268	49,416	1,051	60,230	65,375
August	19,176	5.3	380	39,741	1,377	65,904	55,732	20,882	5.5	272	51,244	1,161	61,399	70,068
September	19,742	5.8	373	43,545	868	66,519	62,177	21,295	5.8	279	48,736	905	63,692	67,112
October	19,719	5.7	472	42,581	909	68,547	59,835	23,092	6.2	309	51,303	1,476	63,758	73,162
November	22,295	6.6	354	47,100	1,200	59,934	77,162	26,711	7.4	314	53,075	872	57,702	85,284
December	27,577	7.7	403	59,673	496	59,681	87,410	34,859	9.0	316	61,000	1,017	55,216	97,644
Total	[2] 274,684	6.6	4,565	[3] 577,700	13,217	59,681	838,045	[2] 292,519	6.8	3,322	[3] 637,401	12,060	55,216	925,647
By refining district:														
East Coast	31,566	6.5	--	558,771	606	26,653	625,859	30,873	6.4	--	[4] 616,990	1,502	23,622	686,554
Appalachian No. 1	5,559	10.1				580		6,709	11.4				676	
Appalachian No. 2	1,402	7.0				414		1,730	8.8				305	
Indiana, Illinois, Kentucky, etc	45,728	6.1	576	3,953	316	7,215	66,261	50,219	6.4	578	[5] 5,458	511	5,825	80,084
Minnesota, Wisconsin, etc	6,435	8.1				903		7,016	8.4				1,002	
Oklahoma, Kansas, etc	5,325	1.6				839		6,883	2.1				935	
Texas Inland	3,020	2.1				187		3,608	2.4				310	
Texas Gulf Coast	37,494	4.2				4,937		37,682	4.0				3,893	
Louisiana Gulf Coast	16,585	3.3	1,783	6,553	3,167	2,006	27,618	18,695	3.2	1,781	6,212	4,667	1,646	31,757
Arkansas, Louisiana Inland, etc	3,246	5.9				110		4,428	9.1				205	
New Mexico	549	3.5				4		634	3.9				10	
Rocky Mountain	9,886	6.7	252	41	3	919	9,347	9,152	6.3	252	--	--	386	9,622
West Coast	107,889	16.7	1,954	8,382	9,125	14,914	108,960	114,890	16.6	711	8,741	5,380	16,401	117,630
Total	[2] 274,684	6.6	4,565	[3] 577,700	13,217	59,681	838,045	[2] 292,519	6.8	3,322	[3] 637,401	12,060	55,216	925,647

p Preliminary.
[1] Represents crude oil used as fuel on leases and for general industrial purposes.
[2] Sulfur content in thousands of barrels: 0%-0.50%—1971, 50,526; 1972, 64,855: 0.51%-1.00%—1971, 57,805; 1972, 70,824. 1.01%-2.00%—1971, 97,824; 1972, 92,652. Over 2.0%—1971, 68,524; 1972, 64,188.
[3] Sulfur content in thousands of barrels: 0%-50%—1971, 109,328; 1972, 208,137. 0.51%-1.00%—1971, 166 606; 1972, 168,764. 1.01%-2.00%—1971, 77,225; 1972, 79,316. Over 2.0%, 1971, 224,541; 1972, 191,184.
[4] Includes 9,939,000 barrels of foreign crude oil to be burned as fuel.
[5] Includes 480,000 barrels of foreign crude oil to be burned as fuel.

Table 45.—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 [1]	Kerosine type	Total	Naphtha type	Kerosine type	Total	Naphtha type	Kerosine type	Total	Naphtha type [2]	Kerosine type	Total	Naphtha type	Kerosine type	Total
1971															
By month:															
January	6,787	19,111	25,898	684	2,828	3,512	112	--	112	6,910	20,680	27,590	7,070	22,248	29,318
February	6,472	17,209	23,681	903	4,621	5,524	86	89	175	7,040	19,992	27,032	7,159	22,429	29,588
March	7,087	19,236	26,323	565	4,101	4,666	125	21	146	6,917	20,214	27,131	7,650	23,094	30,744
April	7,100	18,021	25,121	462	3,560	4,022	233	40	273	6,606	20,658	27,264	7,640	21,097	28,737
May	7,179	18,581	25,760	637	4,376	5,013	114	23	137	6,692	21,822	28,514	7,616	21,770	29,386
June	7,064	18,269	25,333	1,401	4,778	6,179	121	--	121	6,934	21,819	28,753	8,102	23,050	31,152
July	6,881	17,512	24,393	1,086	5,157	6,243	91	--	91	7,202	21,645	28,847	7,608	22,843	30,451
August	6,627	18,246	24,873	1,413	4,688	6,101	116	--	116	6,681	21,015	27,696	8,445	23,564	32,009
September	7,553	17,490	25,043	1,245	4,536	5,781	108	46	154	6,645	21,437	28,082	8,726	21,558	30,284
October	7,390	18,878	26,268	916	4,127	5,043	15	--	15	6,795	20,364	27,159	8,141	24,078	32,219
November	7,645	18,490	26,135	870	4,352	5,222	99	--	99	7,005	20,934	27,939	8,206	22,272	30,478
December	7,541	18,305	25,846	910	7,496	8,406	97	--	97	6,990	20,747	27,737	8,369	25,988	34,357
Total	85,326	219,348	304,674	11,092	54,620	65,712	1,317	219	1,536	6,990	20,747	27,737	94,732	273,991	368,723
By refining district:															
East Coast	2,167	11,409	13,576	8,549	29,717	38,266	--	--	--	255	3,905	4,160	28,183	110,666	138,849
Appalachian No. 1	735	740	1,475							123	278	401			
Appalachian No. 2	--	--	--							67	163	230			
Indiana, Illinois, Kentucky, etc	7,836	34,289	42,125							657	3,061	3,718			
Minnesota, Wisconsin, North and South Dakota	1,234	1,496	2,730	--	3,043	3,043	--	--	--	136	720	856	17,737	57,730	75,467
Oklahoma, Kansas, Missouri, etc	8,196	10,962	19,158							824	908	1,732			
Texas Inland	8,388	8,474	16,862							397	1,022	1,419			
Texas Gulf Coast	13,156	48,280	61,436							917	2,374	3,291			
Louisiana Gulf Coast	10,070	40,297	50,367	--	2,959	2,959	--	--	--	934	1,361	2,295	14,617	17,845	32,462
Arkansas, Louisiana Inland, etc	1,764	12	1,776							397	548	945			
New Mexico	1,980	52	2,032							237	94	331			
Rocky Mountain	3,929	4,413	8,342	--	--	--	--	--	--	230	340	570	2,199	6,766	8,965
West Coast	25,871	58,924	84,795	2,548	18,901	21,444	1,317	219	1,536	1,816	5,973	7,789	31,996	80,984	112,980
Total	85,326	219,348	304,674	11,092	54,620	65,712	1,317	219	1,536	6,990	20,747	27,737	94,732	273,991	368,723

1972 p															
By month:															
January	5,696	18,618	24,314	836	4,705	5,541	99	--	99	6,658	19,199	25,857	6,765	24,871	31,636
February	6,596	19,498	26,094	610	5,778	6,388	18	--	18	6,339	18,891	25,230	7,507	25,584	33,091
March	6,921	21,178	28,099	391	4,776	5,167	104	--	104	6,966	20,181	27,147	6,581	24,664	31,245
April	7,020	19,275	26,295	444	3,270	3,714	15	10	25	6,471	21,097	27,568	7,944	21,619	29,563
May	6,873	20,638	27,511	1,123	3,812	4,935	145	--	145	6,093	22,792	28,885	8,229	22,755	30,984
June	6,825	18,940	25,765	1,121	7,636	8,757	152	--	152	5,889	22,467	28,356	7,998	26,901	34,899
July	6,416	20,660	27,076	825	4,286	5,111	127	--	127	5,844	23,585	29,429	7,159	23,828	30,987
August	6,793	19,162	25,955	730	4,882	5,612	15	--	15	6,517	25,132	31,649	6,835	22,497	29,332
September	5,833	18,478	24,311	894	4,796	5,690	16	--	16	6,149	24,448	30,597	7,079	23,958	31,037
October	6,077	19,407	25,484	1,657	7,220	8,877	16	--	16	5,933	22,700	28,633	7,934	28,375	36,309
November	5,742	18,247	23,989	1,835	3,699	5,534	17	--	17	5,647	21,003	26,650	7,846	23,643	31,489
December	5,773	19,363	25,136	1,532	4,316	5,848	187	36	223	6,147	19,346	25,493	6,618	25,300	31,918
Total	76,565	233,464	310,029	11,998	59,176	71,174	911	46	957	6,147	19,346	25,493	88,495	293,995	382,490
By refining district:															
East Coast	1,454	10,545	11,999	8,336	30,294	38,630	--	--	--	377	3,651	4,028	23,375	121,449	144,824
Appalachian No. 1	650	678	1,328							55	256	311			
Appalachian No. 2	--	--	--							51	196	247			
Indiana, Illinois, Kentucky, etc	7,552	35,421	42,973							659	3,238	3,897			
Minnesota, Wisconsin, North and South Dakota	1,446	1,397	2,843	--	2,789	2,789	--	--	--	152	795	947	16,510	60,838	77,348
Oklahoma, Kansas, Missouri, etc	6,686	10,404	17,090							771	957	1,728			
Texas Inland	5,084	9,040	14,124							314	1,234	1,548			
Texas Gulf Coast	12,487	53,702	66,189							925	2,213	3,138			
Louisiana Gulf Coast	7,692	47,540	55,232	--	4,451	4,451	1	10	11	512	1,149	1,661	15,063	18,383	33,446
Arkansas, Louisiana Inland, etc	1,553	8	1,561							285	419	704			
New Mexico	2,073	50	2,123							184	42	226			
Rocky Mountain	4,079	4,513	8,592	--	--	--	--	--	--	284	338	622	2,476	7,329	9,805
West Coast	25,809	60,166	85,975	3,662	21,642	25,304	910	36	946	1,578	4,858	6,436	31,071	85,996	117,067
Total	76,565	233,464	310,029	11,998	59,176	71,174	911	46	957	6,147	19,346	25,493	88,495	293,995	382,490

p Preliminary.
[1] Includes naphtha type jet fuel produced at natural gas processing plants: Arkansas, Louisiana Inland, etc., 1971, 9.
[2] Includes naphtha type jet fuel stored at natural gas processing plants: Arkansas, Louisiana Inland, etc., 1971, 2; 1972, 2.

Table 46.—Salient statistics of lubricants in the United States, by month and refining district

(Thousand barrels unless otherwise stated)

1971	Production: Bright stock	Production: Neutral	Production: Other grades	Production: Total	Yield (%)	Imports (all types)	Exports (all types)	Stocks, end of period: Bright stock	Stocks, end of period: Neutral	Stocks, end of period: Other grades	Stocks, end of period: Total	Domestic demand (all types)
By month:												
January	526	2,412	2,324	5,262	1.5	1	1,249	1,383	4,853	8,916	15,152	3,574
February	613	2,163	2,165	4,941	1.5	2	1,255	1,500	4,801	8,871	15,172	3,668
March	534	2,507	2,750	5,791	1.6	1	1,376	1,573	4,986	8,904	15,463	4,125
April	631	2,352	2,680	5,663	1.7	1	1,528	1,387	4,825	8,955	15,167	4,432
May	675	2,590	2,438	5,703	1.7	--	1,439	1,433	4,807	9,206	15,446	3,985
June	653	2,392	2,716	5,761	1.7	1	1,056	1,512	4,912	8,951	15,375	4,777
July	526	2,548	2,647	5,721	1.6	--	1,377	1,397	4,876	8,875	15,148	4,571
August	478	2,773	2,351	5,602	1.6	--	1,598	1,240	4,894	8,671	14,805	4,347
September	610	2,274	2,322	5,206	1.5	2	1,359	1,245	4,926	8,873	15,044	3,610
October	619	2,366	2,522	5,507	1.6	--	1,113	1,296	4,669	8,909	14,874	4,564
November	652	2,508	1,979	5,139	1.5	1	1,290	1,461	4,694	8,758	14,913	3,811
December	590	2,426	2,161	5,177	1.4	1	1,185	1,404	4,910	8,735	15,049	3,857
Total	7,107	29,311	29,055	65,473	1.6	10	15,825	1,404	4,910	8,735	15,049	49,321
By refining district:												
East Coast	535	3,786	3,902	8,223	1.7	6	3,679	200	592	2,645	3,437	20,539
Appalachian No. 1	1,303	2,235	545	4,083	7.4			129	285	633	1,047	
Appalachian No. 2	--	8	--	8	1			--	22	76	98	
Indiana, Illinois, Kentucky, etc	654	2,644	2,197	5,495	0.7	2	658	106	494	999	1,599	13,234
Minnesota, Wisconsin, etc	--	--	--	--	--			--	--	36	36	
Oklahoma, Kansas, etc	800	3,187	1,475	5,462	1.7			228	544	192	959	
Texas Inland	--	--	87	87	.1			--	--	39	39	
Texas Gulf Coast	1,767	8,297	16,584	26,648	3.0			293	1,433	2,667	4,393	
Louisiana Gulf Coast	685	5,971	1,221	7,877	1.6	--	10,509	105	972	203	1,280	9,889
Arkansas, Louisiana Inland, etc	--	773	1,185	1,958	3.6			--	75	291	366	
New Mexico	--	--	--	--	--			--	--	7	7	
Rocky Mountain	45	204	163	412	.3	--	11	14	70	15	99	334
West Coast	1,318	2,206	1,696	5,220	.8	2	968	334	423	932	1,689	5,325
Total	7,107	29,311	29,055	65,473	1.6	10	15,825	1,404	4,910	8,735	15,049	49,321

1972 p												
By month:												
January	614	2,402	2,451	5,467	1.5	1	1,441	1,423	5,011	8,891	15,325	3,751
February	584	2,159	2,184	4,927	1.5	1	990	1,462	4,877	8,797	15,136	4,127
March	559	2,381	2,456	5,396	1.5	--	1,528	1,315	4,506	8,608	14,429	4,575
April	463	2,452	2,280	5,195	1.6	2	1,337	1,273	4,446	8,003	13,722	4,567
May	542	2,611	2,543	5,696	1.6	1	1,143	1,216	4,592	7,921	13,729	4,547
June	511	2,643	2,440	5,594	1.6	1	1,130	1,157	4,520	8,218	13,895	4,299
July	554	2,378	2,466	5,398	1.4	112	1,131	1,092	4,379	7,955	13,426	4,848
August	530	2,729	2,526	5,785	1.5	63	1,248	1,054	4,351	7,878	13,283	4,743
September	492	2,329	2,516	5,337	1.5	78	1,134	1,044	4,351	7,883	13,278	4,286
October	563	2,433	2,631	5,627	1.5	122	1,166	1,031	4,147	8,071	13,249	4,612
November	572	2,381	2,438	5,391	1.5	170	1,365	1,088	3,772	7,996	12,856	4,589
December	556	2,365	2,615	5,536	1.4	118	1,382	1,099	3,857	8,315	13,271	3,857
Total	6,540	29,263	29,546	65,349	1.5	669	14,995	1,099	3,857	8,315	13,271	52,801
By refining district:												
East Coast	356	2,903	3,606	6,865	1.4	661	3,452	39	426	2,382	2,847	20,951
Appalachian No. 1	1,301	2,439	389	4,129	7.0			205	273	568	1,046	
Appalachian No. 2	--	12	--	12	--			--	--	294	294	
Indiana, Illinois, Kentucky, etc	498	3,260	1,498	5,256	.7	5	457	103	587	774	1,464	13,426
Minnesota, Wisconsin, etc	--	--	--	--	--			--	--	34	34	
Oklahoma, Kansas, etc	654	3,180	1,418	5,252	1.6			181	404	139	724	
Texas Inland	--	--	98	98	.1			--	--	87	87	
Texas Gulf Coast	1,512	8,440	18,024	27,976	3.0			249	1,054	2,499	3,802	
Louisiana Gulf Coast	751	5,645	1,298	7,694	1.3	--	9,728	49	586	277	912	11,573
Arkansas, Louisiana Inland, etc	--	887	1,169	2,056	4.2			--	63	271	334	
New Mexico	--	--	--	--	--			--	--	9	9	
Rocky Mountain	57	195	143	395	.3	--	5	11	74	12	97	871
West Coast	1,411	2,302	1,903	5,616	.8	3	1,353	262	390	1,019	1,671	5,980
Total	6,540	29,263	29,546	65,349	1.5	669	14,995	1,099	3,857	8,315	13,271	52,801

p Preliminary.

Table 47.—Salient statistics of liquefied gases (excluding ethane) in the United States, by month and refining district

(Thousand barrels unless otherwise stated)

	1971								1972 p							
	Refinery production	Yield (%)	Production at gas processing plants	Imports	Exports	LPG used at refineries	Total stocks, end of period	Domestic demand	Refinery production	Yield (%)	Production at gas processing plants	Imports	Exports	LPG used at refineries	Total stocks, end of period	Domestic demand
By month:																
January	9,558	2.7	28,738	3,046	805	8,269	53,394	44,598	9,690	2.7	29,666	4,331	891	9,243	79,161	45,740
February	9,353	2.9	26,381	2,399	751	7,129	46,454	37,193	9,576	2.8	27,882	3,520	878	8,450	68,206	42,605
March	10,679	3.1	28,679	1,735	813	6,208	49,166	31,360	10,329	2.9	29,678	3,556	1,106	7,196	68,575	34,892
April	10,215	3.1	27,688	1,639	800	5,224	58,220	24,464	10,048	3.0	29,124	1,778	777	6,062	75,362	27,324
May	10,353	3.1	28,366	1,570	658	5,030	70,813	22,008	10,555	3.0	28,917	1,856	836	5,853	87,601	22,400
June	10,578	3.0	26,599	1,562	707	5,053	81,840	21,952	10,121	2.9	27,628	1,610	809	5,298	95,787	25,066
July	10,715	3.0	27,144	1,479	770	5,382	93,021	22,005	10,761	2.9	28,127	1,598	848	5,734	104,150	25,541
August	11,043	3.0	28,046	1,409	754	5,439	101,603	25,723	10,671	2.8	28,276	1,780	1,012	5,554	109,003	29,308
September	9,400	2.7	27,686	1,691	745	6,134	105,863	27,665	10,045	2.7	27,447	2,019	941	6,046	113,265	28,262
October	9,677	2.8	28,525	2,953	823	7,708	106,644	31,816	9,885	2.6	29,316	3,294	1,083	7,858	109,323	37,496
November	9,114	2.8	27,963	2,852	826	8,663	100,516	36,568	9,359	2.6	28,881	3,283	1,065	9,187	96,448	44,146
December	10,267	2.9	31,295	3,320	938	9,456	91,348	43,656	10,142	2.6	29,103	3,776	1,223	8,712	78,665	50,869
Total	120,952	2.9	337,110	25,655	9,390	79,695	91,348	369,008	121,182	2.8	344,045	32,401	11,469	85,193	78,665	413,649
By refining district:																
East Coast	16,666	3.4	4,325	4,775	20	954	6,159	51,321	16,488	3.4	4,786	5,336	39	251	4,831	57,076
Appalachian No. 1	1,212	2.2				24			1,432	2.4				90		
Appalachian No. 2	367	1.8				--			324	1.6				--		
Indiana, Illinois, Kentucky, etc	16,727	2.2	56,037	10,859	85	11,230	30,169	96,967	17,034	2.2	56,319	14,441	96	11,750	25,716	126,872
Minnesota, Wisconsin, etc	1,472	1.8				3,179			1,506	1.8				3,415		
Oklahoma, Kansas, etc	8,541	2.6				10,222			8,279	2.5				11,107		
Texas Inland	3,603	2.5				8,397			3,578	2.4				8,764		
Texas Gulf Coast	31,818	3.5				17,416			30,945	3.3				18,418		
Louisiana Gulf Coast	20,305	4.0	260,652	794	7,894	15,205	53,773	187,878	21,411	3.6	265,505	787	9,839	19,037	46,850	192,529
Arkansas, Louisiana Inland, etc	1,394	2.6				753			948	1.9				1,168		
New Mexico	520	3.3				757			459	2.8				672		
Rocky Mountain	2,373	1.6	9,276	3,060	--	3,306	442	10,131	2,248	1.6	11,584	5,405	--	3,272	386	15,012
West Coast	15,954	2.5	6,820	6,167	1,391	8,252	805	22,711	16,530	2.4	5,851	6,432	1,495	7,249	882	22,160
Total	120,952	2.9	337,110	25,655	9,390	79,695	91,348	369,008	121,182	2.8	344,045	32,401	11,469	85,193	78,665	413,649

p Preliminary.

Table 48.—Salient statistics of ethane (including ethylene) in the United States, by month and refining districts

(Thousand barrels)

	1971					1972 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	6,190	797	6,987	1,331	6,975	7,467	820	8,287	3,265	8,387
February	5,989	727	6,716	1,511	6,536	7,788	824	8,612	3,677	8,200
March	6,427	761	7,188	1,844	6,855	8,633	821	9,454	4,112	9,019
April	6,310	777	7,087	2,066	6,865	7,802	786	8,588	4,589	8,111
May	6,488	682	7,170	2,083	7,153	8,274	737	9,011	5,127	8,473
June	6,473	840	7,313	2,034	7,362	7,958	715	8,673	5,423	8,377
July	6,898	745	7,643	2,110	7,567	8,680	783	9,463	5,690	9,196
August	7,228	772	8,000	2,372	7,738	8,687	757	9,444	5,888	9,246
September	6,632	679	7,311	2,310	7,373	8,535	723	9,258	6,086	9,060
October	7,232	765	7,997	2,739	7,568	9,060	811	9,871	6,170	9,787
November	7,119	853	7,972	3,076	7,635	8,720	718	9,438	6,719	8,889
December	7,538	868	8,406	3,365	8,117	9,087	702	9,789	7,052	9,456
Total	80,524	9,266	89,790	3,365	87,744	100,691	9,197	109,888	7,052	106,201
By refining district:										
East Coast	--	217	217	--	1,882	--	--	--	--	1,712
Appalachian No. 1	1,665	--	1,665			1,712	--	1,712		
Appalachian No. 2	--	--	--			--	--	--		
Indiana, Illinois, Kentucky, etc	7,064	--	7,064	935	10,396	7,232	--	7,232	986	11,308
Minnesota, Wisconsin, etc	--	--	--			--	--	--		
Oklahoma, Kansas, etc	3,073	612	3,685			3,537	590	4,127		
Texas Inland	26,494	97	26,591			40,260	104	40,364		
Texas Gulf Coast	14,837	4,395	19,232			16,520	4,802	21,322		
Louisiana Gulf Coast	23,358	3,334	26,692	2,429	74,836	27,538	3,147	30,685	6,064	92,588
Arkansas, Louisiana Inland, etc	1,253	--	1,253			817	--	817		
New Mexico	2,760	--	2,760			3,035	--	3,035		
Rocky Mountain	20	--	20	1	19	40	3	43	2	42
West Coast	--	611	611	--	611	--	551	551	--	551
Total	80,524	9,266	89,790	3,365	87,744	100,691	9,197	109,888	7,052	106,201

p Preliminary.

Table 49.—Salient statistics of petrochemical feedstocks[1] in the United States, by month and refining district

(Thousand barrels)

	Production				Imports (naphtha 400°)	Exports (other)	Stocks, end of period			Domestic demand (all types)
	Still gas	Naphtha 400°	Other	Total			Naphtha 400°	Other	Total	
1971										
By month:										
January	1,135	4,372	2,230	7,737	620	495	1,349	1,755	3,104	8,377
February	1,575	4,549	2,134	8,258	385	275	1,682	1,578	3,260	8,212
March	1,242	4,864	2,757	8,863	125	593	1,477	1,683	3,160	8,495
April	1,433	4,801	3,686	9,920	47	505	1,605	1,738	3,343	9,279
May	1,131	4,378	3,535	9,044	532	309	1,519	1,778	3,297	9,313
June	1,372	4,442	3,497	9,311	592	665	1,641	1,830	3,471	9,064
July	1,509	3,898	3,573	8,980	362	158	1,514	1,989	3,503	9,152
August	1,966	4,204	3,315	9,485	789	752	1,452	1,838	3,290	9,735
September	1,688	4,128	4,055	9,871	616	268	1,391	1,927	3,318	10,191
October	1,158	5,014	3,875	10,047	203	658	1,402	1,797	3,199	9,711
November	984	4,210	3,845	9,039	290	356	1,335	1,911	3,246	8,926
December	965	5,236	4,192	10,393	548	231	1,732	2,154	3,886	10,070
Total	16,158	54,096	40,694	110,948	5,109	5,265	1,732	2,154	3,886	110,525
By refining district:										
East Coast	1,355	3,056	103	4,514	--	766	--	--	--	7,536
Appalachian No. 1	18	--	456	474			--	13	13	
Appalachian No. 2	--	--	--	--			--	--	--	
Indiana, Illinois, Kentucky, etc	1,769	3,926	2,307	8,002	--	58	333	159	492	11,708
Minnesota, Wisconsin, etc	118	--	14	132			--	--	--	
Oklahoma, Kansas, etc	61	1,915	428	2,404			101	137	238	
Texas Inland	8	1,487	2,871	4,366			2	341	343	
Texas Gulf Coast	7,796	37,125	13,392	58,313			1,110	591	1,701	
Louisiana Gulf Coast	--	1,443	19,444	20,887	5,109	1,890	--	533	533	81,976
Arkansas, Louisiana Inland, etc	--	--	129	129			--	4	4	
New Mexico	--	--	--	--			--	--	--	
Rocky Mountain	145	--	227	372	--	9	--	10	10	373
West Coast	4,888	5,144	1,323	11,355	--	2,542	186	366	552	8,932
Total	16,158	54,096	40,694	110,948	5,109	5,265	1,732	2,154	3,886	110,525

1972 p										
By month:										
January	1,230	4,646	3,920	9,796	130	579	1,360	1,876	3,236	9,997
February	1,055	4,390	4,057	9,502	181	386	1,200	1,915	3,115	9,418
March	1,033	4,380	3,907	9,320	389	314	1,199	1,602	2,801	9,709
April	935	5,005	4,742	10,682	21	309	1,213	1,881	3,094	10,101
May	1,095	4,723	4,164	9,982	581	297	1,138	1,714	2,852	10,508
June	1,147	4,866	3,567	9,580	210	429	1,130	1,701	2,831	9,382
July	1,378	4,685	4,253	10,316	274	363	1,035	1,692	2,727	10,331
August	1,444	5,041	4,499	10,984	301	333	1,190	1,634	2,824	10,855
September	1,144	4,303	4,751	10,198	332	99	1,096	1,653	2,749	10,506
October	1,500	4,575	4,972	11,047	340	135	910	1,445	2,355	11,646
November	1,360	4,957	4,729	11,046	87	823	1,120	1,601	2,721	9,944
December	1,357	5,456	4,760	11,573	332	390	982	1,784	2,766	11,470
Total	14,678	57,027	52,321	124,026	3,178	4,457	982	1,784	2,766	123,867
By refining district:										
East Coast	945	5,392	66	6,403	--	710	--	--	--	9,163
Appalachian No. 1	74	--	665	739			--	13	13	
Appalachian No. 2	--	--	--	--			--	--	--	
Indiana, Illinois, Kentucky, etc	2,610	4,241	2,293	9,144	--	47	101	152	253	15,991
Minnesota, Wisconsin, etc	--	--	--	--			--	--	--	
Oklahoma, Kansas, etc	2,070	2,147	451	4,668			85	74	159	
Texas Inland	274	1,461	3,469	5,204			1	249	250	
Texas Gulf Coast	7,647	38,732	20,063	66,442			687	526	1,213	
Louisiana Gulf Coast	79	337	21,882	22,298	3,178	1,507	--	437	437	91,843
Arkansas, Louisiana Inland, etc	5	--	225	230			--	4	4	
New Mexico	12	--	--	12			--	--	--	
Rocky Mountain	226	--	79	305	--	13	--	1	1	333
West Coast	736	4,717	3,128	8,581	--	2,180	108	328	436	6,537
Total	14,678	57,027	52,321	124,026	3,178	4,457	982	1,784	2,766	123,867

p Preliminary.
1 Produced at petroleum refineries (excluding ethane and liquefied gases).

Table 50.—Statistical summary of petroleum asphalt and road oil

(Thousand short tons) [1]

	1968	1969	1970	1971	1972 p
Petroleum asphalt:					
Production	24,629	24,671	26,665	28,553	28,235
Imports (including natural)	1,134	866	1,127	1,312	1,684
Exports	78	84	65	55	61
Stocks (end of period)	3,646	3,046	2,869	3,855	3,934
Apparent domestic consumption	25,664	26,053	27,905	28,823	29,779
Petroleum asphalt shipments:					
Paving	20,690	21,333	23,594	23,821	24,100
Roofing	4,767	4,080	4,248	4,362	5,248
All other	2,922	2,743	1,870	1,840	1,773
Total	28,379	28,156	29,712	30,023	31,121
Road oil:					
Production	1,241	1,652	1,708	1,592	1,444
Stocks (end of period)	100	160	115	164	237
Apparent domestic consumption	1,287	1,592	1,753	1,543	1,371
Shipments	1,025	1,116	1,753	1,543	1,371

p Preliminary.
[1] Converted from barrels to short tons (5.5 barrels = 1 short ton).

Table 51.—Salient statistics of petroleum asphalt in the United States, by month and refining district

(Thousand short tons) [1]

	1971					1972 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	1,494	97	6	3,576	878	1,482	80	5	4,377	1,035
February	1,406	40	4	4,133	884	1,477	88	5	4,828	1,108
March	1,833	145	5	4,636	1,470	1,810	57	6	5,317	1,372
April	2,198	98	4	5,044	1,884	2,068	100	3	5,643	1,838
May	2,555	100	4	5,142	2,554	2,714	131	5	5,632	2,851
June	2,965	106	5	4,590	3,619	2,908	158	5	5,198	3,495
July	3,159	124	4	4,335	3,534	3,100	138	4	4,794	3,639
August	3,163	153	6	3,665	3,979	3,180	210	8	3,768	4,408
September	2,947	186	5	3,287	3,506	3,024	224	7	3,423	3,587
October	2,736	104	4	3,002	3,120	2,744	158	5	3,129	3,192
November	2,322	104	3	3,199	2,226	2,071	183	4	3,354	2,025
December	1,775	55	5	3,855	1,169	1,657	157	4	3,934	1,229
Total	28,553	1,312	55	3,855	28,823	28,235	1,684	61	3,934	29,779
By refining district:										
East Coast	5,712			944		5,107			966	
Appalachian No. 1	303	1,161	10	81	8,177	295	1,605	9	71	7,996
Appalachian No. 2	231			107		263			96	
Illinois, Indiana, Kentucky, etc	5,961	29	6	643	9,949	5,725	10	8	697	10,227
Minnesota, Wisconsin, North Dakota	1,099			204		1,153			201	
Oklahoma, Kansas, etc	2,894			475		2,651			395	
Texas Inland	1,229			134		1,292			110	
Texas Gulf Coast	1,737			146		1,551			129	
Louisiana Gulf Coast	2,645	122	12	163	5,613	2,847	69	7	216	5,959
Arkansas, Louisiana Inland, etc	1,310			134		1,483			156	
New Mexico	169			40		185			63	
Rocky Mountain	1,803	--	2	392	1,677	1,884	--	3	357	2,086
West Coast	3,460	--	25	392	3,407	3,799	--	34	477	3,511
Total	28,553	1,312	55	3,855	28,823	28,235	1,684	61	3,934	29,779

p Preliminary.
[1] Converted from barrels to short tons (5.5 barrels = 1 short ton).

Table 52.—Salient statistics of road oil in the United States, by month and refining district

(Short tons)[1]

	1971			1972[p]		
	Production	Stocks (end of period)	Domestic demand	Production	Stocks (end of period)	Domestic demand
By month:						
January	96,181	188,909	22,182	52,364	185,636	30,364
February	62,727	236,909	14,727	64,727	234,727	15,636
March	108,000	318,364	26,545	115,455	318,545	31,636
April	94,364	358,182	54,546	111,454	369,091	60,909
May	144,000	376,364	125,818	139,636	354,545	154,182
June	177,273	323,091	230,546	207,091	371,273	190,364
July	247,455	301,636	268,909	209,273	335,636	244,909
August	248,545	242,364	307,818	209,273	302,364	242,545
September	163,091	192,000	213,455	152,000	265,455	188,909
October	120,909	171,636	141,273	108,182	233,454	140,182
November	78,909	159,818	90,727	49,636	230,909	52,182
December	50,364	163,636	46,545	25,091	237,273	18,727
Total	1,591,818	163,636	1,543,091	1,444,182	237,273	1,370,545
By refining district:						
East Coast	5,091	--	122,545	8,909	--	122,363
Appalachian No. 1	120,364	4,000		112,545	3,091	
Appalachian No. 2	--	--		--	--	
Indiana, Illinois, Kentucky, etc	615,091	60,909	791,091	497,273	62,182	700,182
Minnesota, Wisconsin, North Dakota	39,273	--		37,636	727	
Oklahoma, Kansas, etc	170,000	8,364		170,546	11,636	
Texas Inland	32,727	1,636		12,546	--	
Texas Gulf Coast	1,273	--		6,000	--	
Louisiana Gulf Coast	--	--	33,091	--	--	20,182
Arkansas, Louisiana Inland, etc	--	--		--	--	
New Mexico	--	--		--	--	
Rocky Mountain	341,454	52,364	313,818	208,000	13,455	249,636
West Coast	266,545	36,363	282,546	390,727	146,182	278,182
Total	1,591,818	163,636	1,543,091	1,444,182	237,273	1,370,545

[p] Preliminary.
[1] Converted from barrels to short tons (5.5 barrels=1 short ton)

Table 53.—Salient statistics of special naphthas in the United States, by month and refining district

(Thousand barrels unless otherwise stated)

	1971							1972 p						
	Production at refineries	Yield (%)	Production at gas processing plants	Imports	Exports	Total stocks, end of period [1]	Domestic demand	Production at refineries	Yield (%)	Production at gas processing plants	Imports	Exports	Total stocks, end of period [1]	Domestic demand
By month:														
January	2,370	0.7	30	110	103	6,213	2,387	2,502	0.7	24	304	117	5,594	2,503
February	1,979	.6	24	430	233	6,029	2,384	2,466	.7	20	24	72	5,575	2,457
March	2,651	.7	27	34	113	5,682	2,946	2,663	.8	24	7	169	4,903	3,197
April	2,314	.7	25	2	146	5,727	2,150	2,753	.8	22	52	101	5,231	2,398
May	2,253	.7	27	57	114	5,448	2,502	2,674	.8	22	4	153	5,087	2,691
June	2,270	.7	24	46	98	5,308	2,382	2,383	.7	21	4	98	4,585	2,812
July	2,495	.7	27	2	129	5,208	2,495	2,864	.8	22	24	230	4,842	2,423
August	2,185	.6	25	259	129	5,279	2,269	2,997	.8	22	160	117	4,958	2,946
September	2,309	.7	24	141	63	4,997	2,693	2,791	.8	20	5	120	5,025	2,629
October	2,746	.8	23	141	162	5,212	2,533	2,546	.7	23	256	117	4,818	2,915
November	2,371	.7	24	340	77	5,463	2,407	2,636	.7	21	4	91	5,132	2,256
December	2,312	.6	49	262	88	5,384	2,614	2,821	.7	23	19	102	5,232	2,661
Total	28,255	.7	329	1,824	1,455	5,384	29,762	32,096	.7	264	863	1,487	5,232	31,888
By refining district:														
East Coast	532	.1	--	1,580	357	1,351	7,030	200	--	--	508	288	1,169	7,793
Appalachian No. 1	345	.6	--			80		339	.6	--			63	
Appalachian No. 2	264	1.3	--			25		282	1.4	--			23	
Indiana, Illinois, Kentucky, etc	3,373	.5	--	61	85	763	7,318	3,755	.5	--	49	163	761	8,296
Minnesota, Wisconsin, etc	--	--	--			84		--	--	--			83	
Oklahoma, Kansas, etc	1,375	.4	20			168		1,330	.4	13			157	
Texas Inland	1,057	.7	4			133		1,219	.8	--			115	
Texas Gulf Coast	14,367	1.6	--			1,861		18,014	1.9	--			2,022	
Louisiana Gulf Coast	404	.1	--	170	904	33	10,017	307	.1	--	250	894	55	10,464
Arkansas, Louisiana Inland, etc	1,126	2.1	305			165		1,269	2.6	251			153	
New Mexico	1	--	--			--		--	--	--			--	
Rocky Mountain	205	.1	--	13	--	34	222	205	.1	--	56	12	35	228
West Coast	5,206	.8	--	--	109	687	5,175	5,176	.7	--	--	135	596	5,107
Total	28,255	.7	329	1,824	1,455	5,384	29,762	32,096	.7	264	863	1,487	5,232	31,888

p Preliminary.
[1] Includes inventories at natural gas processing plants: Arkansas, Louisiana Inland, etc., 1971, 11; 1972, 8.

Table 54.—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	
1971											
By month:											
January	92	253	180	525	8	140	209	399	463	1,071	315
February	87	217	249	553	8	154	200	388	500	1,088	390
March	109	268	267	644	--	178	207	356	474	1,037	517
April	109	234	266	609	14	163	227	316	498	1,041	456
May	89	275	252	616	13	145	215	377	478	1,070	455
June	96	245	287	628	13	143	222	396	477	1,095	473
July	93	223	191	507	--	150	208	404	492	1,104	348
August	96	249	224	569	12	137	191	387	492	1,070	478
September	209	241	166	616	12	145	208	406	456	1,070	483
October	82	255	172	509	--	93	204	404	458	1,066	420
November	111	320	182	613	13	58	235	452	433	1,120	514
December	71	292	187	550	--	154	228	439	450	1,117	399
Total	1,244	3,072	2,623	6,939	93	1,660	228	439	450	1,117	5,248
By refining district:											
East Coast	371	1,083	546	2,000	2	662	54	211	71	336	2,697
Appalachian No. 1	200	95	328	623			43	22	104	169	
Appalachian No. 2	--	14	--	14			--	--	--	--	
Indiana, Illinois, Kentucky, etc	127	248	153	528	--	39	3	18	87	108	1,094
Minnesota, Wisconsin, etc	--	--	--	--			--	--	--	--	
Oklahoma, Kansas, etc	235	225	94	554			47	13	14	74	
Texas Inland	75	--	--	75			21	--	--	21	
Texas Gulf Coast	176	553	795	1,524			29	51	90	170	
Louisiana Gulf Coast	49	396	492	937	91	888	26	59	54	139	860
Arkansas, Louisiana Inland, etc	--	--	--	--			--	--	--	--	
New Mexico	--	--	--	--			--	--	--	--	
Rocky Mountain	11	59	22	92	--	--	5	24	18	47	88
West Coast	--	399	193	592	--	71	--	41	12	53	509
Total	1,244	3,072	2,623	6,939	93	1,660	228	439	450	1,117	5,248

1972 p											
By month:											
January	65	250	197	512	13	117	227	422	472	1,121	404
February	101	265	128	494	2	98	241	480	376	1,097	422
March	101	335	135	571	3	167	243	515	348	1,106	398
April	69	232	170	471	4	88	220	482	365	1,067	426
May	68	260	220	548	2	131	190	459	375	1,024	462
June	80	241	173	494	3	68	188	435	347	970	483
July	81	253	183	517	58	90	204	462	365	1,031	424
August	79	278	170	527	29	90	197	438	358	993	504
September	82	244	188	514	46	62	207	432	375	1,014	477
October	74	273	162	509	38	56	202	449	387	1,038	467
November	78	260	166	504	78	94	200	447	389	1,036	490
December	77	276	134	487	59	68	201	469	391	1,061	453
Total	955	3,167	2,026	6,148	335	1,129	201	469	391	1,061	5,410
By refining district:											
East Coast	171	828	261	1,260	305	479	23	117	5	145	
Appalachian No. 1	237	148	421	806			63	95	67	225	2,923
Appalachian No. 2	--	--	--	--			--	--	--	--	
Indiana, Illinois, Kentucky, etc	9	205	192	406			2	10	118	130	
Minnesota, Wisconsin, etc	--	--	--	--	5	35	--	--	--	--	969
Oklahoma, Kansas, etc	265	246	104	615			48	18	13	74	
Texas Inland	69	--	--	69			20	--	--	20	
Texas Gulf Coast	141	611	834	1,586			21	42	156	219	
Louisiana Gulf Coast	53	509	64	626	25	557	25	137	1	163	781
Arkansas, Louisiana Inland, etc	--	--	--	--			--	--	--	--	
New Mexico	--	--	--	--			--	--	--	--	
Rocky Mountain	10	63	27	100	--	--	4	23	19	46	128
West Coast	--	557	123	680	--	58	--	27	12	39	609
Total	955	3,167	2,026	6,148	335	1,129	201	469	391	1,061	5,410

p Preliminary.

[1] Conversion factor: 280 pounds to the barrel.

Table 55.—Salient statistics of petroleum coke in the United States, by month and refining district [1]

(Thousand barrels unless otherwise stated)

	1971							1972 p						
	Market-able	Produc-tion catalyst	Total	Yield (%)	Exports	Stocks (end of period)	Domes-tic demand	Market-able	Produc-tion catalyst	Total	Yield (%)	Exports	Stocks (end of period)	Domes-tic demand
By month:														
January	4,787	4,226	9,013	2.6	2,207	5,443	6,660	5,356	4,136	9,492	2.8	1,069	8,049	7,819
February	4,657	3,602	8,259	2.6	1,919	5,686	6,147	5,417	3,997	9,414	2.8	1,454	8,798	7,211
March	5,465	3,802	9,267	2.6	2,424	5,850	6,629	5,527	4,035	9,562	2.7	3,446	8,006	6,908
April	5,447	3,712	9,159	2.8	2,432	5,753	6,824	5,181	3,669	8,850	2.6	2,653	7,747	6,456
May	5,341	3,674	9,015	2.7	2,547	6,242	5,979	5,423	3,642	9,065	2.6	2,668	7,686	6,458
June	5,192	3,914	9,106	2.6	2,646	5,959	6,743	5,361	3,743	9,104	2.6	2,705	7,944	6,141
July	5,083	4,090	9,173	2.5	1,248	6,596	7,288	5,386	4,035	9,421	2.5	2,281	8,304	6,780
August	5,389	4,360	9,749	2.7	1,320	7,693	7,332	5,858	5,338	11,196	3.0	3,009	8,067	8,424
September	5,089	3,844	8,933	2.6	1,569	9,499	5,558	5,639	4,919	10,558	2.9	3,317	7,742	7,566
October	5,312	3,951	9,263	2.7	1,809	8,967	7,986	5,932	5,162	11,094	3.0	2,910	7,848	8,078
November	5,087	3,827	8,914	2.6	3,805	7,919	6,157	5,925	4,814	10,739	3.0	2,896	7,423	8,268
December	5,464	3,799	9,263	2.6	3,143	7,445	6,594	5,809	5,461	11,270	2.9	2,667	7,816	8,210
Total	62,313	46,801	109,114	2.6	27,069	7,445	79,897	66,814	52,951	119,765	2.8	31,075	7,816	88,319
By refining district:														
East Coast	4,702	7,083	11,785	2.4	291	1,127	11,459	4,995	8,192	13,187	2.8	395	1,042	13,113
Appalachian No. 1	--	150	150	.3		--		--	236	236	.4		--	
Appalachian No. 2	--	--	--	--		--		--	129	129	.7		--	
Indiana, Illinois, Kentucky, etc	8,461	9,584	18,045	2.4	2,095	328	28,861	9,692	10,537	20,229	2.6	2,319	691	31,220
Minnesota, Wisconsin, etc	2,095	1,009	3,104	3.9		363		2,136	1,269	3,405	4.1		620	
Oklahoma, Kansas, etc	6,648	3,252	9,900	3.0		169		7,158	3,246	10,404	3.1		177	
Texas Inland	515	1,890	2,405	1.7		1		523	2,288	2,811	1.8		12	
Texas Gulf Coast	8,061	12,281	20,342	2.3		277		8,186	13,501	21,687	2.3		306	
Louisiana Gulf Coast	7,307	5,734	13,041	2.5	9,881	303	28,039	8,948	5,394	14,342	2.4	9,569	112	30,451
Arkansas, Louisiana Inland, etc	1,365	700	2,065	3.8		333		610	348	958	2.0		438	
New Mexico	--	111	111	.7		--		--	176	176	1.1		--	
Rocky Mountain	1,149	1,897	3,046	2.0	--	1,805	2,956	1,350	2,209	3,559	2.5	--	1,803	3,561
West Coast	22,010	3,110	25,120	3.9	14,802	2,739	8,582	23,216	5,426	28,642	4.1	18,792	2,615	9,974
Total	62,313	46,801	109,114	2.6	27,069	7,445	79,897	66,814	52,951	119,765	2.8	31,075	7,816	88,319

p Preliminary.
[1] Conversion factor: 5.0 barrels to the short ton.

Table 56.—Production of miscellaneous finished oils at refineries and natural gas processing plants in the United States in 1972, by district and class

(Thousand barrels)

District	Absorption	Petrolatum	Specialty oils	Petrochemicals	Other products	Total
East Coast	--	--	1,311	763	118	2,192
Appalachian No. 1	15	110	36	10	--	171
Appalachian No. 2	--	--	27	14	--	41
Indiana, Illinois, Kentucky, etc	86	13	660	659	30	1,448
Minnesota, Wisconsin, North Dakota, South Dakota	--	--	--	133	--	133
Oklahoma, Kansas, etc	108	216	789	--	307	1,420
Texas Inland	137	--	1,116	972	154	2,379
Texas Gulf	27	294	863	2,517	542	4,243
Louisiana Gulf	656	72	249	870	57	1,904
Arkansas, Louisiana Inland	102	--	59	33	--	194
Rocky Mountain, New Mexico	1	34	--	43	--	78
West Coast	19	25	1,227	705	213	2,189
Total:						
1972	1,151	764	[1] 6,337	6,719	1,421	16,392
1971	1,279	588	6,380	5,951	1,229	15,427

[1] Specialty oils include hydraulic, 236; insulating, 325; medicinal, 341; rust preventatives, 13; sand-frac, 1,116; spray oils, 294; and other, 4,012.

Table 57.—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
1971													
Crude petroleum	34,772	37,655	43,235	45,207	46,540	50,337	54,768	58,755	57,012	59,617	59,557	65,962	613,417
Petroleum products:													
Motor gasoline	2,158	1,309	1,991	1,893	1,566	1,541	1,652	1,676	1,718	1,115	2,304	2,735	21,658
Jet fuel:													
Naphtha type	684	903	565	462	637	1,401	1,086	1,413	1,245	916	870	910	11,092
Kerosine type	2,828	4,621	4,101	3,560	4,376	4,778	5,157	4,688	4,536	4,127	4,352	7,496	54,620
Total jet fuel	3,512	5,524	4,666	4,022	5,013	6,179	6,243	6,101	5,781	5,043	5,222	8,406	65,712
Liquefied gases:													
Butane	1,290	981	657	934	1,069	901	1,033	955	1,024	2,013	1,566	1,626	14,049
Propane	1,756	1,418	1,078	705	501	661	446	454	667	940	1,286	1,694	11,606
Total liquefied gases	3,046	2,399	1,735	1,639	1,570	1,562	1,479	1,409	1,691	2,953	2,852	3,320	25,655
Kerosine	1	--	1	--	--	--	--	--	48	23	9	107	189
Distillate fuel oil	6,484	5,200	5,585	3,237	2,874	3,509	3,327	2,841	2,963	3,679	5,098	10,986	55,783
Residual fuel oil	55,193	49,635	57,598	47,229	46,634	43,540	45,231	39,741	43,545	42,581	47,100	59,673	577,700
Petrochemical feedstocks	620	385	125	47	532	592	362	789	616	203	290	548	5,109
Special naphthas	110	430	34	2	57	46	2	259	141	141	340	262	1,824
Lubricants	1	2	1	1	--	1	--	--	2	--	1	1	10
Wax	8	8	--	14	13	13	--	12	12	--	13	--	93
Asphalt	531	218	796	539	552	585	685	840	1,021	574	571	304	7,216
Plant condensate	203	368	514	502	557	1,576	1,594	1,528	1,857	1,638	1,126	1,858	13,321
Unfinished oils	3,019	2,591	2,674	3,268	3,020	3,527	4,420	4,686	4,367	4,358	3,884	5,379	45,193
Total petroleum products	74,886	68,069	75,720	62,393	62,388	62,671	64,995	59,882	63,762	62,308	68,810	93,579	819,463
Total crude and products	109,658	105,724	118,955	107,600	108,928	113,008	119,763	118,637	120,774	121,925	128,367	159,541	1,432,880

1972p

Crude petroleum	63,419	60,344	64,066	60,129	66,958	62,544	67,635	65,463	70,909	78,003	68,978	82,687	811,135
Petroleum products:													
Motor gasoline	1,574	1,903	2,076	1,569	2,287	2,244	2,136	2,512	2,084	2,195	2,080	2,127	24,787
Jet fuel:													
Naphtha type	836	610	391	444	1,123	1,121	825	730	894	1,657	1,835	1,532	11,998
Kerosine type	4,705	5,778	4,776	3,270	3,812	7,636	4,286	4,882	4,796	7,220	3,699	4,316	59,176
Total jet fuel	5,541	6,388	5,167	3,714	4,935	8,757	5,111	5,612	5,690	8,877	5,534	5,848	71,174
Liquefied gases:													
Butane	1,814	1,485	1,997	958	1,095	1,000	1,067	1,029	1,146	1,603	1,564	1,792	16,550
Propane	2,517	2,035	1,559	820	761	610	531	751	873	1,691	1,719	1,984	15,851
Total liquefied gases	4,331	3,520	3,556	1,778	1,856	1,610	1,598	1,780	2,019	3,294	3,283	3,776	32,401
Kerosine	1	24	--	1	1	--	41	28	83	45	116	186	526
Distillate fuel oil	6,125	5,931	7,792	5,662	4,086	2,883	3,119	2,862	2,963	6,299	6,820	11,849	66,391
Residual fuel oil	58,658	55,761	59,718	50,265	48,770	49,455	49,416	51,244	48,736	51,303	53,075	61,000	637,401
Petrochemical feedstocks	130	181	389	21	581	210	274	301	332	340	87	332	3,178
Special naphthas	304	24	7	52	4	4	24	160	5	256	4	19	863
Lubricants	1	1	--	2	1	1	112	63	78	122	170	118	669
Wax	13	2	3	4	2	3	58	29	46	38	78	59	335
Asphalt	438	483	312	548	721	868	762	1,157	1,233	867	1,010	864	9,263
Plant condensate	1,748	1,758	2,196	1,782	2,701	2,414	2,770	3,809	3,039	2,963	3,365	3,383	31,428
Unfinished oils	5,520	4,189	3,234	3,542	2,495	3,011	3,339	3,600	3,956	4,214	3,846	4,759	45,705
Total petroleum products	84,384	80,165	84,450	68,940	68,440	71,460	68,760	72,657	70,264	80,813	79,468	94,320	924,121
Total crude and products	147,803	140,509	148,516	129,069	135,398	134,004	136,395	138,120	141,173	158,816	148,446	177,007	1,735,256

p Preliminary.

[1] Imports for onshore use 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 Department of the Interior. All other import figures are compiled from Department of Commerce data.

Table 58.—Crude oil and petroleum products imported into the United States, by country and receiving district

(Thousand barrels)

Country and PAD district	Crude oil[1]	Gasoline	Special naphtha	Kerosine	Distillate fuel oil[1,2]	No. 4 distillate fuel oil[3]	Residual fuel oil[1,2]	Military jet fuel	Commercial jet fuel	Liquefied gases	Plant condensate	Asphalt	Unfinished oils[1]	Lubricants	Wax	Petrochemical feedstocks	Total
1971																	
North America:																	
Canada	263,294	203	647	42	470	212	12,505	--	45	21,710	13,288	500	103	4	14	--	312,825
Mexico	--	--	--	--	--	--	1,424	--	--	4	--	--	8,569	--	2	--	9,999
Total	263,294	203	647	42	470	212	13,929	--	45	21,714	13,288	500	8,672	4	16	--	322,824
Central America and Caribbean:																	
Bahamas	--	--	145	--	404	175	47,843	--	4,549	--	--	--	1,886	--	--	--	54,827
British West Indies	--	--	--	--	--	--	142	--	--	--	--	--	--	--	--	--	142
Netherlands Antilles	--	117	80	--	10,969	6,973	116,412	150	20,494	230	--	3,151	5,991	--	13	--	157,607
Panama	--	--	141	--	305	--	336	--	906	--	--	--	526	--	--	--	2,214
Puerto Rico	--	20,442	--	--	8,369	--	--	--	--	--	--	--	4,294	--	--	1,680	34,785
Trinidad and Tobago	--	--	25	--	4,310	3,982	48,492	2,795	8,407	--	--	7	262	--	--	2,473	66,771
Virgin Islands	--	709	--	126	5,322	--	77,198	5,492	--	5	--	--	9,699	--	--	921	99,472
Total	--	21,268	391	126	29,679	11,130	290,423	8,437	34,356	235	--	3,158	22,658	--	13	5,074	415,818
South America:																	
Argentina	--	--	--	--	--	--	120	--	--	--	--	--	--	--	--	--	120
Bolivia	798	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	798
Brazil	--	--	--	--	--	--	1,184	--	--	--	--	--	--	--	--	--	1,184
Chile	261	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	261
Columbia	3,175	--	--	--	280	--	6,224	--	--	--	--	--	--	--	--	--	9,679
Venezuela	110,574	40	675	21	20,328	9,334	212,518	2,142	9,985	3,183	33	3,526	9,257	--	52	--	372,334
Total	114,808	40	675	21	20,608	9,334	220,046	2,142	9,985	3,183	33	3,526	9,257	--	52	--	384,376
Europe:																	
Belgium	--	--	--	--	--	--	1,715	--	255	--	--	--	--	--	--	--	1,970
France	--	--	--	--	--	--	1,777	--	--	--	--	--	--	1	--	35	1,813
Italy	--	--	--	--	1,806	1,391	25,653	--	1,186	--	--	--	--	1	--	--	28,646
Netherlands	--	--	--	--	--	--	6,674	--	112	--	--	32	--	1	12	--	6,831
Norway	--	--	--	--	--	--	367	--	--	--	--	--	--	--	--	--	367
Romania	--	--	--	--	1,611	1,611	243	--	--	--	--	--	--	--	--	--	1,854
Spain	--	147	--	--	210	210	3,826	--	--	--	--	--	--	--	--	--	4,183
Sweden	--	--	--	--	--	--	--	--	--	3	--	--	--	--	--	--	3
United Kingdom	--	--	--	--	150	150	3,190	--	153	--	--	--	--	--	--	--	3,493
Total	--	147	--	--	3,777	3,362	43,445	--	1,706	3	--	32	--	3	12	35	49,160

Middle East:																	
Abu Dhabi	29,026	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	29,026
Bahrain	--	--	--	--	742	--	1,007	--	2,656	--	--	--	181	--	--	--	4,586
Iran	38,576	--	--	--	--	--	--	--	1,591	157	--	--	494	--	--	--	40,818
Iraq	3,932	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3,932
Kuwait	10,650	--	111	--	--	--	--	--	--	--	--		2,411	--	--	--	13,172
Saudi Arabia	41,971	--	--	--	76	--	3,392	--	89	350	--	--	923	--	--	--	46,801
Yemen	--	--	--	--	--	--	--	--	602	--	--	--	--	--	--	--	602
Total	124,155	--	111	--	818	--	4,399	--	4,938	507	--	--	4,009	--	--	--	138,937
Africa:																	
Algeria	4,685	--	--	--	--	--	870	--	--	--	--	--	--	--	--	--	5,555
Angola	1,301	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,301
Egypt, Arab Republic of	6,924	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6,924
Gabon	--	--	--	--	--	--	111	--	--	1	--	--	--	--	--	--	112
Guinea	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	1
Ivory Coast	--	--	--	--	--	--	136	--	--	--	--	--	--	--	--	--	136
Libya	19,426	--	--	--	168	168	1,453	--	--	1	--	--	--	--	--	--	21,048
Nigeria	34,826	--	--	--	72	72	2,397	--	--	--	--	--	--	--	--	--	37,295
Sierra Leone	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	2
Tunisia	1,199	--	--	--	100	100	--	--	--	--	--	--	--	--	--	--	1,299
Total	68,361	--	--	--	340	340	4,967	--	--	5	--	--	--	--	--	--	73,673
Asia:																	
Australia	2,567	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2,567
Guam	--	--	--	--	--	--	147	513	--	--	--	--	--	--	--	--	660
Indonesia	40,232	--	--	--	--	--	344	--	--	8	--	--	--	--	--	--	40,584
Japan	--	--	--	--	91	--	--	--	931	--	--	--	--	3	--	--	1,025
Malaysia	--	--	--	--	--	--	--	--	2,659	--	--	--	597	--	--	--	3,256
Total	42,799	--	--	--	91	--	491	513	3,590	8	--	--	597	3	--	--	48,092
Total imports	613,417	21,658	1,824	189	55,783	24,378	577,700	11,092	54,620	25,655	13,321	7,216	45,193	10	93	5,109	1,432,880
Imports by PAD district:																	
District I	252,088	21,425	1,580	187	53,373	24,378	558,771	8,549	29,717	4,775	538	6,386	30,651	6	2	--	968,048
District II	137,064	--	61	2	258	--	3,953	--	3,043	10,859	4,580	160	--	2	--	--	159,982
District III	20,449	--	170	--	1,079	--	6,553	--	2,959	794	--	670	2,217	--	91	5,109	40,091
District IV	16,869	--	13	--	--	--	41	--	--	3,060	4,672	--	--	--	--	--	24,655
District V	186,947	233	--	--	1,073	--	8,382	2,543	18,901	6,167	3,531	--	12,325	2	--	--	240,104
1972 p																	
North America:																	
Canada	312,440	513	286	123	2,258	--	28,702	--	1,605	27,853	31,282	408	93	5	16	--	405,584
Mexico	--	--	--	--	--	--	1,775	--	--	--	--	--	5,925	--	10	--	7,710
Total	312,440	513	286	123	2,258	--	30,477	--	1,605	27,853	31,282	408	6,018	5	26	--	413,294

See footnotes at end of table.

Table 58.—Crude oil and petroleum products imported into the United States, by country and receiving district—Continued

(Thousand barrels)

Country and PAD district	Crude oil [1]	Gasoline	Special naphtha	Kerosine	Distillate fuel oil [1 2]	No. 4 distillate fuel oil [3]	Residual fuel oil [12]	Military jet fuel	Commercial jet fuel	Liquefied gases	Plant condensate	Asphalt	Unfinished oils [1]	Lubricants	Wax	Petrochemical feedstocks	Total
Central America and Caribbean:																	
Bahamas	--	--	--	148	1,449	380	54,746	10	6,503	--	--	--	679	--	--	--	63,535
El Salvador	--	--	--	--	--	--	145	--	--	--	--	--	--	--	--	--	145
Honduras	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	1
Leeward and Windward Islands	--	--	--	--	158	--	714	--	19	--	--	--	434	--	--	--	1,325
Netherlands Antilles	--	628	78	--	12,356	7,884	115,550	1,474	18,378	--	--	3,638	2,984	--	--	158	155,244
Panama	--	63	--	--	53	--	314	--	1,497	--	--	--	451	--	--	179	2,557
Puerto Rico	--	20,023	--	255	9,546	--	--	--	833	--	--	--	5,425	653	264	229	37,228
Trinidad	8,626	--	--	--	2,797	2,427	58,010	2,948	8,793	--	--	9	235	--	--	1,122	82,540
Virgin Islands	--	3,006	--	--	8,767	4,827	91,424	3,790	--	--	--	--	13,823	--	--	130	120,940
Total	8,626	23,720	78	403	35,126	15,518	320,904	8,222	36,023	--	--	3,647	24,031	653	264	1,818	463,515
South America:																	
Argentina	407	--	--	--	--	--	15	--	--	--	--	--	--	--	--	--	422
Brazil	--	--	--	--	786	--	994	--	--	--	--	--	--	--	--	--	1,780
Chile	--	--	--	--	--	--	--	--	--	126	--	--	--	--	--	--	126
Colombia	1,695	--	--	--	778	--	3,189	--	--	--	--	--	16	--	11	--	5,689
Ecuador	5,331	--	--	--	--	--	548	--	--	--	--	--	--	--	--	--	5,879
Peru	--	--	--	--	--	--	625	--	--	--	--	--	--	--	--	--	625
Venezuela	93,300	33	499	--	18,001	7,678	210,480	1,412	9,321	3,993	146	5,163	8,615	--	13	293	351,269
Total	100,733	33	499	--	19,565	7,678	215,851	1,412	9,321	4,119	146	5,163	8,631	--	24	293	365,790
Europe:																	
Belgium	--	--	--	--	336	336	6,524	33	298	--	--	--	--	--	--	--	7,191
Denmark	--	--	--	--	--	--	122	--	--	--	--	--	--	--	--	--	122
France	--	--	--	--	--	--	2,156	--	128	--	--	--	--	1	--	166	2,451
Greece	--	--	--	--	--	--	145	--	--	--	--	--	--	--	--	--	145
Italy	--	196	--	--	3,453	3,453	24,979	--	1,411	--	--	--	--	--	--	341	30,380
Netherlands	--	--	--	--	974	108	5,996	13	235	--	--	45	535	3	--	--	7,801
Romania	--	--	--	--	2,973	2,767	948	--	--	--	--	--	--	--	--	--	3,921
Spain	--	136	--	--	84	84	6,171	--	49	--	--	--	--	--	--	--	6,440
Sweden	--	--	--	--	--	--	662	--	--	--	--	--	--	--	--	--	662
Turkey	--	189	--	--	--	--	--	--	--	--	--	--	354	--	--	--	543
U.S.S.R.	323	--	--	--	190	190	2,360	--	--	--	--	--	141	--	--	--	3,014
United Kingdom	--	--	--	--	--	--	3,200	--	--	1	--	--	--	4	--	165	3,370
West Germany	--	--	--	--	--	--	2	--	--	--	--	--	--	3	4	--	9
Total	323	521	--	--	8,010	6,938	53,265	46	2,121	1	--	45	1,030	11	4	672	66,049

Middle East:																	
Bahrain	--	--	--	--	46	--	1,154	3	2,708	--	--	--	1,492	--	--	--	5,403
Iran	49,700	--	--	--	143	--	407	--	1,415	--	--	--	--	--	--	234	51,899
Iraq	1,315	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,315
Kuwait	13,205	--	--	--	931	931	72	--	93	5	--	--	2,083	--	--	--	16,389
Oman	--	--	--	--	--	--	--	--	--	25	--	--	--	--	--	--	25
Qatar	1,263	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,263
Saudi Arabia	63,626	--	--	--	77	--	3,720	196	190	210	--	--	1,381	--	--	--	69,400
United Arab Emirates	26,873	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	26,873
Yemen	--	--	--	--	--	--	--	--	407	--	--	--	--	--	--	--	407
Total	155,982	--	--	--	1,197	931	5,353	199	4,813	240	--	--	4,956	--	--	234	172,974
Africa:																	
Algeria	31,753	--	--	--	--	--	2,081	--	--	--	--	--	--	--	--	--	33,834
Angola	5,785	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5,785
Canary Islands	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	161	161
Egypt	3,091	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3,091
Gabon	--	--	--	--	--	--	109	--	--	--	--	--	--	--	--	--	109
Ghana	--	--	--	--	--	--	240	--	--	--	--	--	--	--	--	--	240
Ivory Coast	--	--	--	--	--	--	360	--	--	--	--	--	--	--	--	--	360
Libya	40,069	--	--	--	--	--	4,668	--	--	120	--	--	--	--	--	--	44,857
Nigeria	88,887	--	--	--	62	62	2,882	--	--	--	--	--	--	--	--	--	91,831
Tunisia	2,520	--	--	--	123	123	65	--	--	--	--	--	--	--	--	--	2,708
Total	172,105	--	--	--	185	185	10,405	--	--	120	--	--	--	--	--	161	182,976
Asia:																	
Burma	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	2
Ceylon	--	--	--	--	--	--	6	--	--	--	--	--	--	--	--	--	6
Indonesia	59,633	--	--	--	--	--	554	--	--	--	--	--	--	--	--	--	60,187
Japan	--	--	--	--	--	--	24	--	2,033	--	--	--	59	--	15	--	2,131
Malaysia	966	--	--	--	--	--	204	422	1,470	68	--	--	300	--	--	--	3,430
Okinawa	--	--	--	--	--	--	--	132	--	--	--	--	475	--	--	--	607
Singapore	--	--	--	--	--	--	2	49	778	--	--	--	--	--	--	--	829
Taiwan	--	--	--	--	--	--	--	163	--	--	--	--	--	--	--	--	163
Total	60,599	--	--	--	--	--	790	766	4,281	68	--	--	834	--	17	--	67,355
Oceania:																	
Australia	327	--	--	--	--	--	262	--	1,012	--	--	--	--	--	--	--	1,601
Guam	--	--	--	--	--	--	45	259	--	--	--	--	--	--	--	--	304
Hawaii Foreign Trade Zone	--	--	--	--	50	--	49	1,094	--	--	--	--	205	--	--	--	1,398
Total	327	--	--	--	50	--	356	1,353	1,012	--	--	--	205	--	--	--	3,303
Total imports	811,135	24,787	863	526	66,391	31,250	637,401	11,998	59,176	32,401	31,428	9,263	45,705	669	335	3,178	1,735,256
Imports by PAD district:																	
District I	354,549	24,609	508	524	64,244	31,250	616,990	8,336	30,294	5,336	798	8,828	30,715	661	305	--	1,146,697
District II	171,338	43	49	2	473	--	5,458	--	2,789	14,441	16,478	55	--	5	5	--	211,136
District III	28,331	--	250	--	1,191	--	6,212	--	4,451	787	--	380	1,548	--	25	3,178	46,353
District IV	14,126	--	56	--	--	--	--	--	--	5,405	11,162	--	--	--	--	--	30,749
District V	242,791	135	--	--	483	--	8,741	3,662	21,642	6,432	2,990	--	13,442	3	--	--	300,321

[p] Preliminary.
[1] Imports of crude and unfinished oils reported to the Bureau of Mines, imports for onshore military jet fuel, distillate and residual fuel oil, and receipts from Puerto Rico, the Virgin Islands, and Guam are based on data reported to the Department of the Interior. All other import figures are compiled from Department of Commerce data.
[2] Includes quantities imported duty-free for supply of vessels and aircraft engaged in foreign trade.
[3] Included in distillate fuel oil.

Table 59.—Petroleum oils, crude and refined, exported from the United States, including shipments, to territories and possessions, by month [1]

(Thousand barrels)

Year and class	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1971													
Crude petroleum	--	2	1	313	8	--	--	--	143	36	--	--	503
Refined products:													
Gasoline: [2]													
Motor	22	26	19	141	43	24	21	23	38	14	16	23	410
Aviation	114	226	65	79	63	72	109	66	236	35	76	98	1,239
Total gasoline	136	252	84	220	106	96	130	89	274	49	92	121	1,649
Jet fuel:													
Naphtha type	112	86	125	233	114	121	91	116	108	15	99	97	1,317
Kerosine type	--	89	21	40	23	--	--	--	46	--	--	--	219
Total jet fuel	112	175	146	273	137	121	91	116	154	15	99	97	1,536
Liquefied gases:													
Butane	451	422	479	438	327	330	386	352	336	393	384	427	4,725
Propane	354	329	334	362	331	377	384	402	409	430	442	511	4,665
Total liquefied gases	805	751	813	800	658	707	770	754	745	823	826	938	9,390
Kerosine	24	20	15	24	5	27	25	4	7	11	11	8	181
Distillate fuel oil	272	241	378	169	248	410	316	259	94	135	161	78	2,761
Residual fuel oil	494	1,355	1,521	1,749	1,167	1,090	991	1,377	868	909	1,200	496	13,217
Petrochemical feedstocks	495	275	593	505	309	665	158	752	268	658	356	231	5,265
Special naphthas	103	238	113	146	114	98	129	129	63	162	77	88	1,455
Lubricants	1,249	1,255	1,376	1,528	1,439	1,056	1,377	1,598	1,359	1,113	1,290	1,185	15,825
Wax	140	154	178	163	145	143	150	137	145	93	58	154	1,660
Coke	2,207	1,919	2,424	2,432	2,547	2,646	1,248	1,320	1,569	1,809	3,805	3,143	27,069
Asphalt	33	23	29	20	21	28	23	33	26	25	16	29	306
Miscellaneous	69	78	106	82	82	107	75	113	121	44	78	73	1,028
Total refined	6,139	6,731	7,776	8,111	6,978	7,194	5,483	6,681	5,693	5,846	8,069	6,641	81,342
Total crude and refined	6,139	6,733	7,777	8,424	6,986	7,194	5,483	6,681	5,836	5,882	8,069	6,641	81,845
1972 p													
Crude petroleum	--	--	--	187	--	--	--	--	--	--	--	--	187

Refined products:													
Gasoline:													
Motor	36	14	28	28	16	15	18	13	38	177	22	20	425
Aviation	104	37	120	26	25	64	60	19	22	14	15	13	529
Total gasoline	140	51	148	54	51	79	78	32	60	191	37	33	954
Jet fuel:													
Naphtha type	99	18	104	15	145	152	127	15	16	16	17	187	911
Kerosine type	--	--	--	10	--	--	--	--	--	--	--	36	46
Total jet fuel	99	18	104	25	145	152	127	15	16	16	17	223	957
Liquefied gases:													
Butane	393	390	534	375	394	379	413	414	415	399	432	429	4,967
Propane	498	488	572	402	442	430	435	598	526	684	633	794	6,502
Total liquefied gases	891	878	1,106	777	836	809	848	1,012	941	1,083	1,065	1,223	11,469
Kerosine	8	3	8	4	4	11	19	8	2	5	10	7	89
Distillate fuel oil	96	138	94	236	52	107	62	18	119	14	46	232	1,214
Residual fuel oil	547	548	1,806	1,507	567	603	1,051	1,161	905	1,476	872	1,017	12,060
Petrochemical feedstocks	579	386	314	309	297	429	363	333	99	135	823	390	4,457
Special naphthas	117	72	169	101	153	98	230	117	120	117	91	102	1,487
Lubricants	1,441	990	1,528	1,337	1,143	1,130	1,131	1,248	1,134	1,166	1,365	1,382	14,995
Wax	117	98	167	88	131	68	90	90	62	56	94	68	1,129
Coke	1,069	1,454	3,446	2,653	2,668	2,705	2,281	3,009	3,317	2,910	2,896	2,667	31,075
Asphalt	27	27	31	19	25	27	24	43	37	25	24	24	333
Miscellaneous	114	78	77	63	104	91	80	89	82	92	90	102	1,062
Total refined	5,245	4,741	8,998	7,173	6,176	6,309	6,384	7,175	6,894	7,286	7,430	7,470	81,281
Total crude and refined	5,245	4,741	8,998	7,360	6,176	6,309	6,384	7,175	6,894	7,286	7,430	7,470	81,468

p Preliminary.
[1] Compiled from records of U.S. Department of Commerce.
[2] Includes benzol, natural gasoline, and antiknock compounds.

Table 60.—Crude oil and petroleum products exported from the United States by countries of destination

(Thousand barrels)

	Crude oil	Gasoline	Naphtha	Jet fuel	Kerosine	Distillate oil	Residual oil	Lubricating oil	Asphalt	Liquefied petroleum gases	Wax	Coke	Petrochemical feedstocks	Miscellaneous products	Total
1971															
North America:															
Canada	60	121	217	2	10	441	3,334	1,540	68	97	116	2,704	581	153	9,444
Mexico	--	237	65	209	1	514	3,521	211	126	9,075	147	998	62	14	15,180
Total	60	358	282	211	11	955	6,855	1,751	194	9,172	263	3,702	643	167	24,624
Central America and Caribbean:															
Bahamas	--	11	4	--	(1)	15	202	22	1	67	(1)	--	2	--	324
Costa Rica	--	--	3	--	--	--	--	49	1	--	9	--	2	3	67
Guatemala	--	(1)	7	--	--	--	--	43	3	19	37	--	1	6	116
Honduras	--	--	2	--	--	--	--	41	5	1	8	--	1	1	59
Jamaica	181	(1)	5	--	--	--	1,476	143	1	(1)	2	21	2	--	1,831
Netherlands Antilles	--	(1)	1	--	--	459	--	262	(1)	--	1	--	(1)	(1)	723
Panama	--	(1)	(1)	--	--	--	120	63	1	--	7	16	1	--	208
Puerto Rico	--	--	43	--	--	16	2	578	3	9	23	246	21	24	965
Trinidad	--	(1)	10	--	--	--	--	41	1	--	6	--	(1)	1	59
Virgin Islands	--	82	1	--	--	20	--	25	1	5	--	--	1	--	135
Others	--	2	23	--	(1)	--	--	101	6	3	20	1	3	9	168
Total	181	95	99	--	--	510	1,800	1,368	23	104	113	284	34	44	4,655
South America:															
Argentina	--	(1)	10	--	(1)	--	(1)	1,031	(1)	--	2	--	9	1	1,053
Bolivia	--	29	--	--	--	--	--	13	--	--	6	--	--	1	49
Brazil	--	277	56	--	1	--	160	1,728	5	57	19	285	421	161	3,170
Chile	--	--	1	--	1	--	(1)	261	4	2	12	--	2	14	297
Columbia	--	(1)	1	--	--	--	(1)	28	1	--	79	--	2	6	117
Ecuador	--	(1)	3	--	--	--	--	28	1	(1)	23	--	1	4	60
Peru	(1)	(1)	(1)	--	--	143	162	90	2	1	19	--	1	5	423
Venezuela	--	(1)	30	--	2	--	1	91	5	(1)	22	74	2	22	249
Others	--	--	3	--	--	--	(1)	60	(1)	(1)	--	--	2	1	66
Total	--	306	104	--	4	143	323	3,330	18	60	182	359	440	215	5,484

Europe:															
Belgium	--	40	55	--	--	(1)	1	741	8	--	50	1,625	29	11	2,560
Denmark	--	(1)	2	--	--	--	(1)	31	--	1	4	--	2	2	42
France	--	3	130	--	(1)	1	1	114	7	--	43	691	703	4	1,697
Greece	--	--	--	--	--	--	6	20	--	--	--	386	--	--	412
Italy	(1)	2	51	--	1	26	631	522	1	1	58	1,512	180	52	3,037
Netherlands	--	291	138	--	2	15	92	700	(1)	(1)	30	2,412	378	53	4,111
Norway	--	(1)	--	--	--	--	--	19	2	--	1	821	1	--	844
Spain	--	(1)	(1)	--	--	--	112	134	(1)	(1)	36	733	188	13	1,216
Sweden	--	(1)	1	--	--	--	(1)	134	1	--	4	366	279	5	790
United Kingdom	120	25	140	--	69	4	419	811	1	30	115	337	1,087	15	3,173
West Germany	--	38	48	--	34	18	1	266	3	(1)	426	3,256	200	36	4,326
Yugoslavia	--	--	--	--	--	--	--	1	(1)	--	--	189	1	--	191
Others	--	2	4	--	(1)	1	21	98	3	2	20	9	9	11	180
Total	120	401	569	--	106	65	1,284	3,591	26	34	787	12,337	3,057	202	22,579
Middle East:															
Bahrain	--	--	(1)	--	--	--	--	7	(1)	--	(1)	83	--	(1)	90
Iran	--	1	(1)	--	--	--	--	26	1	--	(1)	30	1	(1)	59
Israel	--	--	--	--	--	--	1	43	2	--	3	--	24	2	75
Saudi Arabia	--	(1)	1	--	--	(1)	--	76	(1)	--	(1)	--	2	(1)	79
Turkey	--	(1)	1	--	--	--	--	640	(1)	(1)	(1)	--	4	14	659
Others	--	(1)	1	--	--	(1)	1	60	1	--	--	--	3	--	66
Total	--	1	3	--	--	--	2	852	4	--	3	113	34	16	1,028
Africa:															
Egypt, Arab Republic of	--	--	(1)	--	1	--	(1)	39	(1)	--	(1)	--	(1)	(1)	40
Ghana	--	--	--	--	--	--	--	55	1	--	1	318	1	--	376
Nigeria	2	(1)	2	--	6	--	--	37	(1)	(1)	20	--	4	17	88
South Africa, Republic of	--	4	43	--	3	--	227	366	5	1	74	23	137	61	944
Tunisia	--	--	--	--	--	--	--	67	--	--	--	--	--	--	67
Others	--	2	14	--	3	1	--	113	6	--	22	--	9	12	182
Total	2	6	59	--	13	1	227	677	12	1	117	341	151	90	1,697
Asia and Oceania:															
Australia	--	3	56	--	6	--	4	237	3	2	47	693	789	66	1,906
French Pacific Islands	--	91	(1)	--	19	76	130	5	(1)	1	--	--	(1)	--	322
India	--	135	--	--	--	--	--	583	7	--	1	59	1	--	786
Indonesia	--	(1)	(1)	--	--	--	--	118	2	--	2	--	2	6	130
Japan	139	1	211	--	11	552	2,343	1,732	9	13	59	8,788	84	138	14,080
Korea	--	--	--	--	--	--	--	26	(1)	--	22	--	7	--	55
Malaysia	--	(1)	7	--	(1)	--	(1)	118	(1)	--	(1)	67	1	2	195
New Zealand	--	(1)	19	--	(1)	--	1	26	(1)	2	8	234	3	25	318
Philippines	--	(1)	19	--	1	--	224	363	2	--	14	(1)	4	16	643
Singapore	--	156	1	--	2	--	--	86	1	--	1	--	1	3	251
South Vietnam	--	--	--	--	--	--	(1)	490	1	--	27	--	7	--	525
Thailand	--	(1)	3	--	--	--	(1)	305	(1)	--	2	--	2	5	317
Taiwan	--	--	1	--	--	--	(1)	54	1	--	6	92	4	11	169
U.S. Pacific Islands [2]	--	96	4	1,325	7	459	22	5	--	--	--	--	--	--	1,918
Others	1	--	18	--	1	--	2	108	3	1	6	--	1	22	163
Total	140	482	339	1,325	47	1,087	2,726	4,256	29	19	195	9,933	906	294	21,778
Grand total	503	1,649	1,455	1,536	181	2,761	13,217	15,825	806	9,390	1,660	27,069	5,265	1,028	81,845

See footnotes at end of table.

Table 60.—Crude oil and petroleum products exported from the United States by countries of destination—Continued

(Thousand barrels)

	Crude oil	Gasoline	Naphtha	Jet fuel	Kerosine	Distillate oil	Residual oil	Lubricating oil	Asphalt	Liquefied petroleum gases	Wax	Coke	Petrochemical feedstocks	Miscellaneous products	Total
1972															
North America:															
Canada	--	68	321	58	6	84	3,186	1,457	79	117	120	3,370	579	154	9,599
Mexico	--	262	62	199	--	45	1,818	247	176	10,330	148	1,720	36	18	15,061
Total	--	330	383	257	6	129	5,004	1,704	255	10,447	268	5,090	615	172	24,660
Central America and Caribbean:															
Bahamas	--	12	3	--	(1)	16	707	24	(1)	26	--	--	1	(1)	789
British West Indies	--	--	(1)	--	--	--	134	(1)	(1)	(1)	(1)	--	(1)	(1)	134
Jamaica	--	(1)	2	--	--	--	125	112	2	(1)	2	(1)	1	3	247
Netherlands Antilles	--	(1)	1	--	--	161	(1)	90	2	--	1	--	(1)	(1)	255
Panama	--	--	6	--	--	--	542	49	(1)	--	6	--	1	1	605
Puerto Rico	--	2	41	--	(1)	(1)	196	497	--	2	25	408	21	14	1,206
Trinidad	--	(1)	20	--	--	--	--	55	1	--	3	--	2	2	83
Virgin Islands	--	85	--	10	3	15	1	33	3	(1)	2	1	(1)	8	161
Others	--	1	39	--	--	--	--	224	8	8	50	2	15	15	362
Total	--	100	112	10	3	192	1,705	1,084	16	36	89	411	41	43	3,842
South America:															
Argentina	--	(1)	5	--	(1)	8	(1)	410	(1)	--	4	--	11	2	440
Brazil	--	174	86	--	(1)	--	188	1,903	2	47	8	378	325	177	3,288
Chile	--	--	1	--	--	1	8	211	--	--	10	--	1	17	249
Ecuador	--	--	1	--	--	--	--	26	2	1	10	--	1	3	44
Peru	--	(1)	(1)	--	(1)	--	(1)	88	(1)	--	5	--	1	5	99
Venezuela	--	2	50	--	2	--	3	96	6	--	12	68	1	20	260
Others	--	(1)	6	--	1	--	1	105	1	4	6	--	4	9	137
Total	--	176	149	--	3	9	200	2,839	11	52	55	446	344	233	4,517
Europe:															
Belgium	--	11	42	--	--	--	135	959	3	(1)	23	3,375	22	11	4,581
Denmark	--	(1)	1	--	--	--	238	22	1	(1)	5	--	1	2	270
France	--	3	78	--	--	1	27	108	1	28	40	726	688	3	1,703
Greece	--	(1)	1	--	(1)	--	202	25	--	(1)	--	246	1	1	476
Ireland	--	--	1	--	--	--	122	12	(1)	--	1	--	(1)	(1)	136
Italy	--	1	52	--	4	27	993	377	2	(1)	82	1,290	273	40	3,141
Netherlands	--	153	161	--	2	63	436	680	--	--	22	2,801	612	75	4,505
Norway	--	--	1	--	--	--	--	16	--	--	1	815	1	2	836
Spain	--	(1)	1	--	--	--	302	104	2	--	14	684	461	4	1,572
Sweden	--	1	1	--	--	--	276	99	1	--	3	534	4	4	923
United Kingdom	--	5	59	--	--	1	1,511	1,051	3	1	45	365	587	16	3,644
West Germany	--	1	52	--	30	1	(1)	441	2	(1)	299	4,884	32	40	5,782
Yugoslavia	--	--	(1)	--	--	--	--	2	--	--	--	121	1	1	125
Others	--	2	6	--	--	1	1	96	3	3	10	3	5	5	135
Total	--	177	456	--	36	94	4,243	3,992	18	32	545	15,344	2,688	204	27,829

Middle East:															
Bahrain	--	(1)	(1)	--	--	--	--	6	(1)	(1)	--	165	1	1	173
Iran	--	(1)	1	--	(1)	--	(1)	37	1	(1)	--	56	1	2	98
Israel	--	(1)	(1)	--	6	--	(1)	46	1	(1)	(1)	(1)	3	2	58
Saudi Arabia	--	(1)	2	--	--	--	--	190	--	(1)	--	--	3	1	196
Turkey	--	(1)	(1)	--	--	--	--	558	--	--	(1)	--	3	14	575
Others	--	(1)	1	--	--	--	(1)	52	2	--	(1)	(1)	2	1	58
Total	--	(1)	4	--	6	--	--	889	4	(1)	(1)	221	13	21	1,158
Africa:															
Egypt, Arab Republic of	--	(1)	(1)	--	--	--	--	151	--	--	(1)	--	(1)	(1)	151
Ghana	--	--	1	--	(1)	--	--	92	(1)	--	--	264	1	2	360
Nigeria	--	1	(1)	--	2	--	--	36	1	--	(1)	--	1	11	52
South Africa, Republic of	--	1	58	--	2	--	330	241	8	2	35	38	121	28	864
Tunisia	--	--	--	--	(1)	--	--	117	(1)	--	(1)	--	--	--	117
Others	--	(1)	11	--	1	--	21	116	8	3	12	(1)	15	13	200
Total	--	2	70	--	5	--	351	753	17	5	47	302	138	54	1,744
Asia and Oceania:															
Australia	--	1	61	--	2	--	2	217	2	2	22	507	499	50	1,365
French Pacific Islands	--	82	--	--	10	12	29	10	1	(1)	--	--	(1)	--	144
India	--	(1)	12	--	--	--	(1)	465	--	(1)	6	81	2	1	567
Indonesia	--	1	1	--	--	--	--	147	(1)	--	1	--	4	18	172
Japan	187	2	125	--	14	203	374	1,246	4	888	55	8,305	90	169	11,662
Malaysia	--	(1)	1	--	--	--	--	130	(1)	--	1	62	(1)	1	195
New Zealand	--	(1)	9	--	--	--	(1)	28	(1)	3	7	193	5	46	291
Philippines	--	2	17	--	1	--	62	285	(1)	(1)	9	(1)	4	14	394
South Vietnam	--	--	(1)	--	--	--	--	303	(1)	--	11	--	1	6	321
Taiwan	--	(1)	1	--	--	--	--	56	2	--	4	68	8	10	149
Thailand	--	(1)	7	--	--	--	(1)	401	--	--	--	--	--	6	414
U.S. Pacific Islands [2]	--	81	47	690	3	575	5	64	--	--	--	--	--	--	1,465
Others	--	(1)	32	--	--	--	85	382	3	4	9	45	5	14	579
Total	187	169	313	690	30	790	557	3,734	12	897	125	9,261	618	335	17,718
Grand total	187	954	1,487	957	89	1,214	12,060	14,995	333	11,469	1,129	31,075	4,457	1,062	81,468

[1] Less than ½ unit.
[2] Data reported by shippers to the Bureau of Mines.

Table 61.—Crude petroleum: World production, by country

(Thousand 42-gallon barrels)

Country	1970	1971	1972 p
North America:			
Canada	461,177	491,846	560,693
Cuba e	800	785	775
Mexico [1]	r 177,599	177,274	185,011
Trinidad and Tobago	51,047	47,148	51,719
United States [1]	3,517,450	3,453,914	3,455,368
South America:			
Argentina	143,428	154,514	158,464
Barbados	--	19	31
Bolivia	8,820	13,206	15,967
Brazil	60,923	63,513	61,088
Chile	12,432	12,883	12,527
Columbia	79,594	78,101	71,674
Ecuador	1,444	1,354	28,579
Peru	26,272	22,588	23,635
Venezuela	1,353,420	1,295,406	1,178,487
Europe:			
Albania	9,995	8,674	10,508
Austria	19,515	17,549	17,284
Bulgaria	2,438	2,336	1,825
Czechoslovakia	1,424	1,356	1,322
Denmark	--	--	622
France	16,825	13,651	10,811
Germany, East	r 439	1,502	1,864
Germany, West	54,427	53,597	51,271
Hungary	14,780	14,879	15,084
Italy	9,575	8,952	7,850
Netherlands	13,080	11,727	10,885
Norway	--	2,081	12,126
Poland	3,146	3,116	2,574
Romania	102,067	102,479	105,296
Spain	1,457	874	1,020
U.S.S.R	2,594,550	2,778,300	2,895,900
United Kingdom	r 838	1,499	2,628
Yugoslavia	21,140	21,932	23,709
Africa:			
Algeria	371,767	279,627	384,858
Angola	36,499	33,922	51,405
Congo (Brazzaville)	137	130	2,522
Egypt, Arab Republic of	119,165	106,993	77,592
Gabon	39,292	41,911	45,671
Libya	1,209,314	1,007,687	819,619
Morocco	335	172	216
Nigeria	395,836	558,375	665,282
Tunisia	34,296	31,542	31,607
Asia:			
Bahrain	27,973	27,346	25,508
Brunei	50,233	47,482	67,008
Burma	6,388	6,652	7,466
China, People's Republic of e	146,000	186,150	216,080
India	52,596	52,091	56,965
Indonesia	311,628	325,673	395,581
Iran	1,397,460	1,661,901	1,843,869
Iraq	569,726	624,312	529,419
Israel e [2]	31,798	44,618	43,920
Japan	5,656	5,529	5,242
Kuwait [3]	r 1,090,039	1,167,329	1,201,346
Malaysia	6,299	25,071	33,867
Oman	121,210	107,430	103,131
Pakistan	3,400	3,000	3,294
Qatar	132,456	156,882	176,545
Saudi Arabia [3]	r 1,387,265	1,741,149	2,202,049
Syrian Arab Republic	29,356	36,462	45,209
Taiwan	638	803	910
Thailand	70	95	47
Turkey	24,776	25,031	24,416
United Arab Emirates:			
Abu Dhabi	252,179	341,007	384,190
Dubai	31,321	45,648	55,942
Oceania:			
Australia	65,149	112,914	119,516
New Zealand [1]	467	804	1,119
Total	r 16,710,826	17,662,793	18,598,008

e Estimate. p Preliminary. r Revised.

[1] Includes field condensate.

[2] Estimates of Israeli production from Sinai peninsula oilfields included with Israel rather than with Arab Republic of 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]

Data for 1972 indicated that demand in the world for phosphate rock exceeded production for the second consecutive year. Estimated world sales in 1972 were 8% higher than sales in 1971. A significant reduction in world stocks reflected efforts to supply the strong demand that developed in 1972

The average unit value of domestic phosphate rock declined from $5.24 in 1971 to $5.09 per ton f.o.b. plant, in 1972. Reasons for the price decline in a period of exceptionally high demand for phosphate rock were not clear. It was speculated that if contracts written in 1970 or the first half of 1971, when prices were depressed, remained in effect through 1972, the increase in domestic and foreign demand would not be reflected by higher prices. The effect of Phase II price controls during 1972 restrained domestic prices and was in part responsible for shifting sales of phosphate rock into the more profitable export market. However, increased competition from North African phosphate rock producers limited phosphate rock price increases in world markets.

Although the demand for phosphatic fertilizers was strong, the demand for elemental phosphorus for industrial purposes was depressed because of restrictions on permissible levels of sodium tripolyphosphate in detergents.

Legislation and Government Programs.—The emphasis of legislative and Government actions was directed toward environmental problems. The Federal Bureau of Mines met with the Board of Directors of the Florida Phosphate Council in response to the phosphate industry's request for Federal aid to find a solution to the phosphate slime dewatering problem. The Bureau of Mines proposed research programs supported by a cost-sharing agreement. The proposal was accepted. The program is described in the technology section of this chapter.

The Governor of Florida signed into law, bills providing for coordinated management of Florida's water resources, purchase of environmentally endangered forests, and State control of land use development. The "Florida Environmental Land and Water Management Act of 1972" will have an effect on the phosphate mining industry. The section on water management gives the Department of Natural Resources the power to conserve, protect, and manage all the waters of the State. The Department of Natural Resources will establish a State-wide water use plan that will impose regulations on well drilling and all consumptive uses of water. The land use section allows the State to purchase or rigidly control development of about 5% of the State's land area. These lands will be designated to be of critical concern to the State and be protected.

The Florida Pollution Control Board adopted safety regulations designed to prevent damaging slime spills from holding ponds associated with phosphate rock processing operations. The Board tightened requirements for construction, operation, and maintenance of dams designed to retain the slimes from the phosphate ore washing plants. The new rules set minimum standards on the dams and emphasized intensive surveillance by State inspectors.

In the suit filed by the Florida Department of Pollution in Polk County Circuit Court, after a slime pond dam broke on December 3, 1971, $10 million in compensation damages and $10 million in punitive damages were sought from Cities Service Co. The punitive damage part of the suit was removed by the Circuit Court and the compensatory damage permitted to stand.

The Attorney General of the State of Florida has renewed his request for a hearing on his motion for a preliminary injunction against the issuance of phosphate

[1] Physical scientist, Division of Nonmetallic Minerals.

mining leases in the Osceola National Forest. The State filed suit in 1971 against the Secretaries of the U.S. Department of the Interior and the U.S. Department of Agriculture after it was disclosed that preferential rights leases had been applied for by several companies in the Osceola National Forest. A moratorium was placed on the issuance of leases by the Secretary of the Interior to permit completion of environmental impact statements. The Attorney General contended that the Environmental Protection Act and other statutes superseded the mining laws that direct the Federal Government to issue mining permits if conditions specified are met.

The Governor of Tennessee signed into law House Bill 1519, which became effective on March 23, 1972. This bill repeals the old strip mine law and gives the State of Tennessee one of the strongest surface mining statutes in the Nation. The phosphate industry may be prohibited from strip mining in areas if this activity will cause severe environmental damage or in areas where the disturbed land cannot be reclaimed. Strict regulations are specified for mining methods, reclamation plans, disposal of overburden, regrading, and revegetation procedures.

A 5% corporate profit tax was enacted by a special session of the Florida State legislature in December 1971, and will affect the phosphate industry in Florida in 1972. The corporate profit tax was predicted to generate approximately $150 million per year.

On April 1, 1972, the State of Florida received its initial payment under the severance tax law enacted in 1971. A total severance tax of $1,221,659 was due for phosphate rock mined from July 1 through December 31, 1971. This initial 6-month payment was based on a 3% assessment rate. This rate will increase to 4% on July 1, 1973, and 5% July 1, 1975. The value per ton of phosphate rock assigned by the Department of Revenue for tax purposes was $3.11. Of the $1,221,659 total, $258,718 was deductable as ad valorem tax credits paid to counties in which the companies operated, one-half of the remainder, $481,470 was returned to the industry for land reclamation, and the remaining $481,470 was deductable from Federal taxable income. The latter resulted in a Federal tax credit of $231,105. These deductions and tax credits reduced actual payments to the State by industry to $250,354 for the 6-month period.

A new State-wide ban on high-phosphate detergents was announced by the Florida Pollution Control Board. Effective the first of 1973, the rule limits the phosphorus content of soaps and detergents to 8.7%. This is the same ceiling imposed by the States of Connecticut, Indiana, Maine, Michigan, and New York. Dade County, Fla., has banned the sale of detergents containing any phosphorus. Some cities, including Chicago, Ill., and Buffalo, N.Y., have total bans on phosphate detergents. The Florida ceiling of 8.7% phosphorus content in detergents applies only to laundry products, not to automatic dishwashing detergents or personal hygiene products such as shampoo or toothpaste. Detergents sold for industrial or institutional use were also exempted from the phosphorus limitation.

Table 1.—Salient phosphate rock statistics

(Thousand short tons and thousand dollars)

	1968	1969	1970	1971	1972
United States:					
Mine production	148,336	121,712	125,514	127,752	126,651
Marketable production	41,251	37,725	38,739	38,886	40,831
Value	$250,692	$208,689	$203,218	$203,828	$207,910
Average per ton	$6.08	$5.53	$5.25	$5.24	$5.09
Sold or used by producers	37,319	36,730	38,765	40,291	43,755
Value	$228,347	$204,409	$203,810	$211,986	$223,005
Average per ton	$6.12	$5.57	$5.26	$5.26	$5.10
Exports	12,099	11,336	11,738	12,587	14,275
P_2O_5 content	3,917	3,685	3,796	4,126	4,673
Value	$75,653	$62,288	$59,980	$64,841	$75,376
Average per ton	$6.25	$5.49	$5.11	$5.15	$5.28
Imports for consumption	116	140	136	84	55
Value	$2,679	$3,554	$3,790	$2,478	$1,416
Average per ton	$23.09	$25.42	$27.87	$29.50	$25.75
Consumption, apparent [1]	25,336	25,534	27,163	27,788	29,535
World: Production	91,466	88,930	93,635	96,040	103,866

[1] Measured by sold or used plus imports minus exports.

DOMESTIC PRODUCTION

Domestic production of marketable phosphate rock was 40,831,000 tons, a 5% increase over that of 1971. The value of the marketable rock was $207,910,000, a 2% increase over that of 1971. The average grade of phosphate ore mined in the United States was 14.7% P_2O_5, and the average grade of marketable rock was 31.4% P_2O_5. The average weight recovery of concentrate and marketable rock as mined was 32.2%, and the P_2O_5 recovery averaged 69.2%. Of the total production in the United States, Florida and North Carolina produced 34,121,000 tons (83.5%), the Western States produced 4,555,000 tons (11.2%), and Tennessee produced 2,154,000 tons (5.3%).

Florida and North Carolina.—Production of marketable phosphate rock was 34,121,000 tons, an increase over that of 1971 of 1,970,000 tons, or 6.1%. The value of marketable rock increased to $173,910,000, an increase over that of 1971 of $6,157,000, or 3.7%.

The average grade of phosphate ore mined was 13.9% P_2O_5, and the average grade of marketable rock was 32.2% P_2O_5. The average weight recovery of concentrate and marketable rock as mined was 29.1%, and the average P_2O_5 recovery was 67.4%.

Companies operating in the Florida land-pebble phosphate fields were Agrico Chemical Co., Borden Chemical Co., Brewster Phosphates, Cities Service Co., W. R. Grace & Co., International Minerals and Chemical Corp. (IMC), Mobil Chemical Co., Poseidon Mines, Inc., P.S.A. Enterprises, Occidental Chemical Co., Swift Agricultural Chemical Corp., and U.S.S. Agri-Chemicals, Inc. Soft rock operators were Howard Phosphate Co., Kellogg Co., Loncala Phosphate Co., Manko Co., Inc., and Sun Phosphate Co.

Texas Gulf, Inc., Lee Creek, N.C., announced that they would increase phosphoric acid capacity by 525 tons per day of P_2O_5.[2] The expansion is scheduled to be completed in 1974.

The Agrico Chemical Division of Continental Oil Co. (Agrico) was sold to the Williams Cos., Tulsa, Okla., Agrico will become a part of Willchemco, Inc., a division of Williams.[3] Agrico announced a $50 million expansion at its Donaldsonville, La., plant to increase the phosphoric acid capacity by 400,000 tons per year of P_2O_5.[4]

IMC and Fertilizantes Fosfatados Mexicanos, S.A. plan to construct a fertilizer complex in central Florida. The $80 million plant will be operated by IMC to produce diammonium phosphate and triple superphosphate. Production of 600,000 tons per year is scheduled for 1974.[5]

CF Industries, Inc., plans to double the size of its Plant City, Fla., fertilizer manufacturing complex.[6] The expansion will increase finished product capacity to 650,000 tons per year of fertilizer. The expansion at Plant City will include a 250,000-ton-per-year phosphoric acid train, two 1,000-ton-per-day sulfuric acid plants, and two granulation units. Scheduled production in 1972 was 4.9 million tons, 5.2 million is planned for 1973, and higher production is anticipated by 1976. Phosphate rock will be purchased from Florida suppliers.

Conserv Chemicals, a division of Conserv, Inc., Lakeland, Fla., plans to reopen the plant purchased from Mobil Oil Corp. in 1971.[7] After modernization and renovation at a cost of several million dollars, the plant is scheduled to start up in 1973 to produce phosphoric acid and fertilizers.

The Phosphate Rock Export Association (Phosrock) that was formed in 1971, established headquarters in Tampa, Fla., in 1972 and after July 1, 1972, handled the sales, supply, and distribution of phosphate rock in the export market of its five member companies. They are Agrico Chemical Co., American Cyanamid Co., W. R. Grace & Co., International Minerals and Chemical Corp., and Occidental Chemical Co.

Western States.—Production of marketable phosphate was 4,555,000 tons, a 9.4% increase over that of 1971. The value of the marketable rock decreased to $23,268,000 or 2.7% below that of 1971. The average grade of mined phosphate ore was 26% P_2O_5, and the average grade of

[2] Chemical Engineering. C. E. Construction Alert. V. 80, No. 8, Apr. 2, 1973, p. 69.
[3] Chemical Marketing Reporter. Agrico Unit Changes Hands. V. 201, No. 19, May 8, 1972, p. 3.
[4] Tampa Tribune. Agrico Expanding. Sept. 22, 1972, pp. 7–13.
[5] Chemical Engineering. C. E. Construction Alert. V. 80, No. 8, Apr. 2, 1973, p. 69.
[6] CF Industries, Inc., Annual Report, 1972. P. 11.
[7] Tampa Tribune. New Phosphate Firm To Begin Fertilizer Production in 1973. Dec. 21, 1972, p. 13.

marketable rock was 28.4% P_2O_5. The weight recovery of concentrate and marketable rock as mined averaged 81.9%, and the average P_2O_5 recovery was 89.1%.

In Idaho, Agricultural Products Corp., Monsanto Co., J. R. Simplot Co., and Stauffer Chemical Co. mined and processed phosphate rock. Cominco American, Inc., mined phosphate rock in Montana. This was the only active underground phosphate mine in the United States. Stauffer Chemical Co. mined phosphate rock in two areas of Utah and also mined phosphate rock in Wyoming.

The Meramec Mining Co., Sullivan, Mo., produced an apatite concentrate from the tailings from the Pea Ridge iron ore mine during the period from 1964 through 1967. This material was marketed in 1972 for phosphoric acid production and will continue to be marketed in the future for this purpose.

Beker Industries, Greenwich, Conn., acquired the superphosphoric acid and diammonium phosphate plant at Conda, Idaho, from El Paso Natural Gas Co. This plant plus the assets of the Mountain Fuel Supply Co., which includes the mine and benefication plant, were the components that formed the Agricultural Products Corp. The first year of production for this company was 1972.

Tennessee.—Production of marketable phosphate rock was 2,154,000 tons, a decline of 417,000 tons or 16.2% from that of 1971. The value of the marketable rock declined 11.7% below that of 1971.

The average grade of phosphate ore mined was 21.4% P_2O_5, and the average grade of the beneficiated rock was 26.1% P_2O_5. The average weight recovery of concentrates was 56.3%, and the P_2O_5 recovery averaged 68.9%.

Hooker Chemical Co., Monsanto Co., Stauffer Chemical Co., and the Tennessee Valley Authority (TVA) mined phosphate rock in Tennessee for production of elemental phosphorus from electric furnaces. Restrictions on the quantity of sodium tripolyphosphate in detergents has reduced the demand for elemental phosphorus from the Tennessee furnaces.

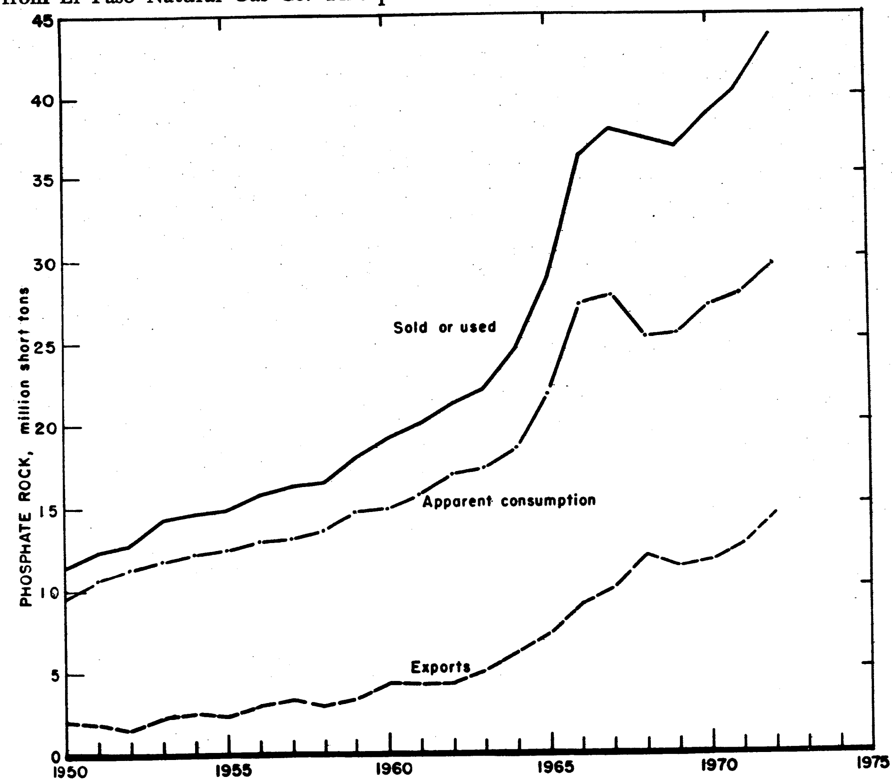

Figure 1.—Phosphate rock (sold or used), apparent consumption, and exports.

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
1971:									
Florida [1]	118,130	16,659	16	3	32,136	10,308	32,151	10,311	167,753
Tennessee	4,750	1,002	W	W	W	W	2,571	684	12,151
Western States [2]	4,872	1,265	2,969	797	1,194	363	4,164	1,160	23,924
Total	127,752	18,926	2,985	800	33,330	10,671	38,886	12,155	203,828
1972:									
Florida [1]	117,263	16,289	20	4	34,101	10,980	34,121	10,984	173,910
Tennessee	3,824	817	W	W	W	W	2,154	563	10,732
Western States [2]	5,565	1,450	3,199	860	1,356	432	4,555	1,292	23,268
Total [3]	126,651	18,557	3,219	864	35,457	11,412	40,831	12,839	207,910

W Withheld to avoid disclosing individual company confidential data.
[1] Includes North Carolina.
[2] Includes Idaho, Montana, Utah, and Wyoming.
[3] Data may not add to totals shown because of independent rounding.

CONSUMPTION AND USES

Apparent consumption of marketable phosphate rock increased 6.3% above that reported in 1971.

According to producers' reports, the quantity of marketable rock sold or used was 43,755,000 tons. This was an increase of 8.6% compared with the quantity sold or used in 1971. The domestic market consumed 67% of this total and 33% was exported.

The consumption pattern in the United States was 24,019,000 tons (81.5%) for fertilizer, 5,173,000 tons (17.5%) for elemental phosphorus production, and 289,000 tons (1.0%) for defluorinated rock and other purposes.

The percent distribution by grade of marketable rock in the United States was as follows:

Grade, percent BPL [1]	Distribution (%)
less than 60	9.5
60–66	6.3
66–70	40.5
70–72	10.3
72–74	22.1
Over 74	11.3

[1] 1.0% BPL (bone phosphate of lime or tricalcium phosphate) = 0.458% P_2O_5.

Florida and North Carolina.—The quantity sold or used increased 11.3% compared with the quantity reported in 1971. The quantity sold or used in the domestic agricultural market was 63% of the total sold or used. The balance, 37%, included exports and a minor quantity for industrial applications.

The consumption pattern of the domestic fraction was 22,889,000 tons (98.0%) for fertilizer, 177,000 tons (0.8%) for elemental phosphorus, 289,000 tons (1.2%) for defluorinated rock, and other purposes.

The percent distribution by grade of marketable rock sold or used from Florida and North Carolina was as follows:

Grade, percent BPL	Distribution (%)
Less than 60	0.1
60–66	5.1
66–70	44.8
70–72	11.2
Over 72	38.8

Western States.—The quantity of marketable rock sold or used increased 1.8% compared with 1971 reported sold or used. Of the total sold or used in the domestic and export markets, 25% was used for agricultural purposes. The pattern of the domestic market was approximately 70% consumed in electric furnaces and 30% used to produce fertilizer. Fifty percent of the marketable rock was less than 60 BPL and the balance distributed in higher grades.

Tennessee.—The quantity of marketable rock sold or used declined 13.7% from that of 1971. All of the marketable rock was consumed domestically and was charged to electric furnaces to produce elemental phosphorus. Curtailment of sodium tripolyphosphates in detergents was responsible for the decline in consumption of phosphate rock in Tennessee.

Table 3.—Florida phosphate rock sold or used by producers, by kind

(Thousand short tons and thousand dollars)

Year	Land pebble [1] Rock	Land pebble [1] P_2O_5 content	Land pebble [1] Value Total	Land pebble [1] Value Average per ton	Soft rock Rock	Soft rock P_2O_5 content	Soft rock Value Total	Soft rock Value Average per ton	Total [2] Rock	Total [2] P_2O_5 content	Total [2] Value Total	Total [2] Value Average per ton
1968	29,571	9,504	173,190	$5.86	30	6	224	$7.47	29,601	9,510	173,413	$5.86
1969	28,835	9,307	155,197	5.38	30	6	221	7.34	28,865	9,313	155,418	5.38
1970	31,111	9,981	157,652	5.07	24	5	168	7.10	31,134	9,986	157,820	5.07
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

[1] Includes North Carolina.
[2] Data may not add to totals shown because of independent rounding.

Table 4.—Tennessee phosphate rock sold or used by producers

(Thousand short tons and thousand dollars)

Year	Rock	P_2O_5 content	Value Total	Value Average per ton
1968	3,065	807	23,646	$7.71
1969 [1]	3,193	851	18,192	5.70
1970 [1]	3,184	864	15,606	4.90
1971	2,596	687	12,281	4.73
1972	2,240	587	11,188	4.99

[1] Includes Alabama.

Table 5.—Phosphate rock sold or used by producers in the United States, by grade and State

(Thousand short tons)

Year and grade, BPL content [1] (percent)	Florida [2] Rock	Florida [2] P_2O_5 content	Tennessee Rock	Tennessee P_2O_5 content	Western States Rock	Western States P_2O_5 content	Total [3] United States Rock	Total [3] United States P_2O_5 content
1971:								
Below 60	33	8	1,877	479	2,590	671	4,500	1,157
60–66	1,676	489	W	W	W	W	2,292	668
66–70	14,334	4,449	W	W	W	W	15,297	4,716
70–72	4,533	1,472	--	--	1,049	332	5,582	1,804
72–74	8,734	2,887	--	--	--	--	8,734	2,887
Plus 74	3,885	1,321	--	--	--	--	3,885	1,321
Total [3]	33,195	10,625	2,596	687	4,500	1,241	40,291	12,553
1972:								
Below 60	34	8	1,826	465	2,304	594	4,164	1,067
60–66	1,897	566	W	W	W	W	2,752	818
66–70	16,543	5,162	W	W	W	W	17,722	5,529
70–72	4,125	1,331	W	W	W	W	4,507	1,451
72–74	W	W	--	--	W	W	9,687	3,213
Plus 74	W	W	--	--	W	W	4,925	1,681
Total [3]	36,934	11,868	2,240	587	4,581	1,299	43,755	13,758

W Withheld to avoid disclosing individual company confidential data.
[1] Bone phosphate of lime, $Ca_3(PO_4)_2$.
[2] Includes North Carolina.
[3] Data may not add to totals shown because of independent rounding.

Table 6.—Phosphate rock sold or used by producers, by use and State

(Thousand short tons)

Use	Florida [1]		Tennessee		Western States		Total [2] United States	
	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content
1971:								
Domestic:								
Agricultural	20,879	6,585	--	--	1,254	366	22,132	6,951
Industrial	385	118	2,596	687	2,590	671	5,572	1,476
Total	21,264	6,703	2,596	687	3,844	1,037	27,704	[r] 8,427
Exports	11,931	3,922	--	--	655	204	12,587	4,126
Total [2]	33,195	10,625	2,596	687	4,500	1,241	40,291	12,553
1972:								
Domestic:								
Agricultural	23,174	7,356	--	--	1,130	361	24,304	7,716
Industrial	W	W	2,240	587	W	W	5,176	1,364
Total	23,174	7,356	2,240	587	1,130	361	29,480	9,080
Exports	W	W	--	--	W	W	14,275	4,673
Total	36,934	11,868	2,240	587	4,581	1,299	43,755	13,753

[r] Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Includes North Carolina.
[2] Data may not add to totals shown because of independent rounding.

Table 7.—Phosphate rock sold or used by producers in the United States, by use

(Thousand short tons and thousand dollars)

Use	1971			1972		
	Rock	P_2O_5 content	Value	Rock	P_2O_5 content	Value
Domestic:						
Fertilizers	[r] 21,777	[r] 6,835	[r] 118,975	23,907	7,587	122,716
Elemental phosphorus	5,516	1,457	24,845	5,173	1,363	22,020
Direct application to the soil	80	24	443	111	34	519
Feed supplement (defluorinated rock only) Other uses	332	111	2,882	289	97	2,374
Total [1]	27,705	8,427	147,145	29,480	9,080	147,629
Exports	12,587	4,126	64,841	14,275	4,673	75,376
Grand total [1]	40,291	12,553	211,986	43,755	13,753	223,005

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

STOCKS

The operating practices of phosphate mining companies in the Western States, Tennessee, and Florida and North Carolina differ with respect to creating stocks of marketable rock. In the Western States, sufficient ore is mined during the mild months of the year to sustain the plants over the winter months. The stocks are depleted when mining is resumed and stocks are not carried over into the next year. Stocks are not maintained in Tennessee.

Stocks are maintained in Florida and North Carolina. Yearend stock of marketable phosphate rock declined from 11,951,000 to 10,513,000 tons, a decrease of 12%. This reflected the heavy demand from both domestic and export markets in 1972.

PRICES

Prices quoted by the Chemical Marketing Reporter for various grades of Florida land-pebble phosphate rock are shown in table 8. These prices are unchanged from 1971 and only reflect a basis for price negotiation between buyer and seller. Tennessee and Western States phosphate rock prices are not published because most of the rock is consumed by the mining companies to produce elemental phosphorus or fertilizer intermediates or end products. The actual prices of Florida and North Carolina phosphate rock sold to either domestic or export markets are not published.

The average 1972 unit value of marketable phosphate rock reported by producers was $5.09 per short ton f.o.b. plant. This was a decrease from $5.24 per ton in 1971. The average unit value of marketable rock sold or used in the domestic market from Florida and North Carolina declined from $5.24 per ton in 1971 to $5.10 per ton in 1972. In the Western States, the unit value of marketable rock sold or used declined from $5.69 per ton in 1971 to $5.13 per ton. The unit value of marketable rock sold or used in Tennessee increased from $4.73 per ton in 1971 to $4.99 per ton in 1972.

The average unit value of marketable phosphate rock exported increased from $5.15 per ton f.o.b. plant, in 1971 to $5.28 per ton in 1972, or 2.5%. The unit value of marketable rock exported from Florida and North Carolina increased 2.8% from 1971 to 1972. The unit values increased from $4.96 to $5.10 per ton f.o.b. plant. The unit value of marketable rock exported from the Western States was $8.68 and $8.76 per ton f.o.b. plant, for 1971 and 1972 respectively. This represented an increase in unit value of 1.0%. Tennessee rock was not exported.

Phosrock, Tampa, Fla., increased prices by $1 per ton on all grades of Florida phosphate rock supplied to export markets. Effective July 1, 1972, f.o.b. Tampa or Jacksonville, the following prices were published for new and renewed contracts.

Grade, % BPL	Price per long ton
66–68	$8.70
70–72	10.02
72–73	10.30
74–75	11.18
76–77	12.28

The Office Cherifien des Phosphates raised the listed prices of all grades of Moroccan phosphate rock $1 per ton effective January 1, 1973, assuring price increases of this order to the West European market.[8] Other major suppliers to the West European market are expected to adjust their prices upward and in line with this general trend.

Table 8.—Prices of Florida land-pebble, unground, washed and dried phosphate rock, in bulk, carlots, at mine, in 1972

(Per short ton)

Grade, % BPL	Price
66–68	$6.50
68–70	7.50
70–72	8.15
74–75	9.20
76–77	10.20

Source: Chemical Marketing Reporter.

FOREIGN TRADE

Industry reported that 14,275,000 tons of marketable phosphate rock was exported in 1972. This was an increase of 13.4% over 1971 exports. Most of the phosphate rock was exported from Florida. Exports from Florida increased significantly over those in 1971.

Exports of phosphate rock from the Western States to Canada increased somewhat over those in 1971. The average unit value per ton as calculated from producers' reports was slightly higher than the unit value calculated for 1971.

Analysis of import data showed that 54,738 tons of phosphate rock was imported. This was 35% less than that reported in 1971. The reports show imports of low-fluorine rock, 40,115 tons from the Netherlands Antilles and 9,111 tons from Mexico, and a shipment of 5,512 tons from Spanish Sahara. The total value of these imports was $1,416,000. The average unit value was $25.75 per ton. Imports are expected to continue to decline.

[8] British Sulphur Corp., Ltd. Phosphate Prices. No. 62, November–December 1972, p. 5.
Conversation with Mr. Daniel Cohen, Chef de la Delegation l'Office Cherifien des Phosphates, Paris, France, Mar. 14, 1973.

Table 9.—U.S. exports of phosphate rock, by grade and country

(Thousand short tons and thousand dollars)

Destination	1971 Quantity	1971 Value	1972 Quantity	1972 Value
Florida phosphate rock:				
Aden	29	131	--	--
Austria	117	817	147	938
Belgium-Luxembourg	673	4,037	732	4,544
Brazil	619	4,533	791	5,867
Canada	2,030	14,392	2,205	16,492
Chile	15	119	55	483
Colombia	73	475	31	229
El Salvador	13	75	12	78
France	536	3,814	497	3,904
Germany, West	1,273	7,660	1,455	8,965
India	407	2,610	454	2,994
Iran	128	979	415	2,965
Italy	1,227	8,878	864	5,962
Japan	2,171	18,598	2,220	20,449
Korea, Republic of	573	4,021	574	3,974
Mexico	803	4,728	785	5,058
Netherlands	557	3,709	715	4,248
Norway	3	28	8	59
Peru	13	136	9	79
Philippines	174	1,282	126	945
Romania	--	--	421	2,770
Spain	135	974	293	2,033
Sweden	49	298	86	563
Switzerland	24	162	3	29
Taiwan	107	768	82	760
United Kingdom	64	454	54	353
Uruguay	23	216	40	484
Other	33	295	48	335
Total	11,869	84,189	13,122	95,560
Other phosphate rock:[1]				
Brazil	(2)	6	3	22
Canada	617	8,451	741	10,001
Colombia	3	177	(2)	8
Costa Rica	1	19	(2)	5
Germany, West	9	104	1	30
Iran	3	250	--	--
Japan	(2)	29	--	--
Mexico	129	1,098	76	753
Netherlands	--	--	(2)	7
Norway	51	352	42	289
Peru	3	25	--	--
Spain	--	--	(2)	8
Venezuela	--	--	1	68
Vietnam, South	--	--	6	625
Other	2	116	(2)	62
Total	818	10,627	870	11,878
Grand total	12,687	94,816	13,992	107,438

[1] Includes colloidal and sintered matrix, Tennessee, Idaho, Montana and soft phosphate rock.
[2] Less than ½ unit.

Table 10.—U.S. exports of superphosphates, by country

(Thousand short tons and thousand dollars)

Destination	1971 Quantity	1971 Value	1972 Quantity	1972 Value
Algeria	65	2,918	14	911
Argentina	5	193	17	1,010
Australia	(1)	7	2	255
Bangladesh	--	--	39	3,050
Belgium-Luxembourg	r 2	r 111	(1)	18
Brazil	253	9,840	489	25,441
Canada	73	3,682	83	4,416
Chile	82	2,715	68	3,405
Colombia	23	907	18	855
Costa Rica	10	431	13	702
Dominican Republic	7	250	13	716
Ecuador	6	234	3	208

See footnotes at end of table.

Table 10.—U.S. exports of superphosphates, by country—Continued

(Thousand short tons and thousand dollars)

Destination	1971		1972	
	Quantity	Value	Quantity	Value
El Salvador	6	335	(1)	2
France	53	1,934	8	355
Germany, West	1	42	1	63
Guyana	2	138	6	205
Hong Kong	1	100	1	80
Indonesia	--	--	83	5,174
Iran	45	1,574	--	--
Italy	41	1,541	37	2,008
Jamaica	5	230	4	207
Japan	18	813	18	974
Mexico	--	--	6	76
Netherlands	17	620	16	840
Nicaragua	1	28	(1)	29
Singapore	(1)	1	20	1,051
Uruguay	6	304	--	--
Venezuela	1	46	1	80
Vietnam, South	10	593	--	--
Yugoslavia	6	281	--	--
Other	9	523	7	334
Total	r 748	r 30,391	967	52,465

r Revised.
1 Less than ½ unit.

Table 11.—U.S. exports of ammonium phosphates, by country

(Thousand short tons and thousand dollars)

Destination	1971		1972	
	Quantity	Value	Quantity	Value
Afars and Issas	--	--	12	1,202
Argentina	29	1,620	42	3,071
Belgium-Luxembourg	52	2,831	23	1,512
Brazil	324	17,279	512	34,235
Canada	49	2,701	57	3,250
Colombia	17	882	43	3,044
Costa Rica	18	1,013	29	2,078
Dominican Republic	11	686	20	1,525
Ecuador	9	352	13	923
El Salvador	40	1,925	34	2,313
Ethiopia	16	1,031	11	815
France	92	4,726	78	4,843
Germany, West	2	115	(1)	17
Greece	--	--	12	950
India	234	12,717	298	19,566
Italy	183	9,253	271	18,029
Japan	48	2,352	26	1,556
Lebanon	21	1,195	52	4,339
Netherlands	41	2,207	27	1,970
New Zealand	7	384	9	641
Pakistan	--	--	84	7,690
Singapore	4	209	16	1,381
Spain	33	1,721	4	161
Uruguay	30	1,680	3	221
Venezuela	21	1,345	--	--
Vietnam, South	5	332	27	2,717
Yugoslavia	18	860	89	6,457
Other	55	3,437	24	1,540
Total	1,359	72,853	1,816	126,046

1 Less than ½ unit.

Table 12.—U.S. exports of mixed chemical fertilizers, by country

(Thousand short tons and thousand dollars)

Destination	1971		1972	
	Quantity	Value	Quantity	Value
Argentina	3	171	1	56
Belgium-Luxembourg	7	253	45	1,211
Brazil	1	236	11	1,173
Canada	80	5,355	61	4,601
Colombia	(1)	7	7	537
Costa Rica	(1)	94	(1)	11
El Salvador	6	331	7	415
France	13	491	5	270
Germany, West	3	975	3	805
Greece	1	129	(1)	73
India	45	2,691	17	2,136
Italy	(1)	7	8	401
Japan	(1)	77	(1)	60
New Zealand	10	512	18	966
Vietnam, South	47	2,228	157	12,498
Other	19	1,758	27	2,506
Total	235	15,315	367	27,719

[1] Less than ½ unit.

Table 13.—U.S. exports of elemental phosphorus, by country

(Thousand short tons and thousand dollars)

Destination	Quantity	Value
Argentina	2	706
Australia	1	388
Canada	4	1,284
Japan	3	970
Mexico	20	7,908
Other	(1)	461
Total	30	11,717

[1] Less than ½ unit.

Table 14.—U.S. imports for consumption of phosphate rock and phosphatic fertilizers

(Thousand short tons and thousand dollars)

Fertilizer	1971		1972	
	Quantity	Value	Quantity	Value
Phosphates, crude and apatite	84	2,478	57	1,544
Phosphatic fertilizers and fertilizer materials	92	6,972	70	3,184
Ammonium phosphates, used as fertilizers	457	28,018	501	31,070
Bone ash, bone dust, bone meal, and bones ground, crude or steamed	5	430	6	484
Dicalcium phosphate	23	1,162	20	976

WORLD REVIEW

The production of phosphate rock from over 30 countries is summarized in table 15. With the exception of the operations in the United States, the majority of phosphate rock production in the rest of the world is from Government-owned operations. They are important to their respective countries to the degree that the industry creates employment and, in several instances, is the principle source of foreign exchange.

Algeria.—The State-owned company, Sonatrach, is planning a significant increase in production of phosphate rock from the Djebel Onk mine for the fertilizer complex at Annaba.[9] The current production of 600,000 tons per year of high-grade material will be increased by an additional 600,000 tons per year of low-grade material that will be used in the expanded fertilizer complex at Annaba. This level of production is expected to be obtained in 1975.

[9] European Council News. V. 22, No. 540, July 7, 1972, p. 14.

The second stage of the planned expansion is now being studied and, if approved, an additional 600,000 tons of ore will be required by the Annaba complex in 1977. Long-range plans anticipate that by 1980 a total of 2.4 million tons per year of phosphate rock will be processed by the Annaba fertilizer complex.

Angola.—The Government has funded the construction of an artificial island, at a 60 foot water depth, connected to the mainland by a 1 mile pier to permit loading deep draft bulk cargo vessels. Clark Canadian Exploration Co. has acquired a 35% interest in Cia. dos Fosfatos de Angola SARL from the Rockefeller family. Remaining shares are owned by private interests in the United Kingdom and Portugal. A schedule to mine and export the phosphate deposits in the Cabinda exclave has not been announced.

Australia.—Broken Hill South, Ltd., is continuing beneficiation and transportation studies of phosphate rock in northwest Queensland. If the project proceeds on schedule, the earliest that concentrates will be available is the late 1970's. The feasibility of a 150-mile pipeline from the deposits to the Gulf of Carpentaria to transport the concentrates as a slurry is being studied.[10]

Brazil.—Serrana S.A. de Mineração at its Jacupiranga mine in the State of São Paulo, mines and beneficiates phosphate bearing igneous rock.[11] In the new beneficiation plant, apatite is floated from the calcite and magnetite to upgrade the concentrate to 36%–38% P_2O_5. From 1.4 million tons per year of ore, 157,000 tons per year of apatite concentrates are produced. A cement plant was scheduled to start production in 1972 and will use the flotation tailings from the phosphate beneficiation plant.

Israel.—Phosphoric acid production declined because of technical difficulties with the Arad Chemical Industry phosphoric acid plant.[12] Although the plant was shut down in early 1972, it was scheduled to be back on stream before the year was out. Domestic rock is acidulated with hydrochloric acid produced from Dead Sea magnesium chloride. The phosphoric acid plant is rated at 166,000 tons per year of P_2O_5. The acid will be marketed in Europe.

Mexico.—Fertilizantes Fosfatados Mexicanos, S.A., announced plans to build a new plant at Coatzacoalcos, Veracruz, to produce liquid fertilizer grade phosphoric acid.[13] Most of this production is destined for export. The new plant will have an initial capacity of 100,000 tons of P_2O_5 per year.

Morocco.—Production of phosphate rock for the year was 16,503,000 tons, an increase of about 25% over the comparable period in 1971.[14] A goal of 16.5 million tons has been established for 1973, and the Office Cherifien des Phosphates has planned new investments to assure production increases during the 1973–78 period. Incremental expansions of mining, beneficiation, and calcining plants are planned. Increased production of from 1 to 2 million additional tons each year is probable if these plans materialize.

Peru.—The Peruvian Government published a resolution in January 1972 that specified that all mining concessions belonging to Ciá. Minera Bayovar, S.A. would revert to the state.[15] The company had not complied with the General Mining Law requiring submission of development plans. The Sechura Desert phosphate rock deposits were most recently held by the Canadian company Minerales Industriales del Peru S.A.

Senegal.—Sales by the Compagnie Senégalaise des Phosphates Taiba were in excess of 1.5 million tons in 1972.[16] Stocks were reduced to meet this demand. Production capacity will be increased from the present level of 1.4 million to about 1.7 million tons per year.

Spanish Sahara.—Test shipments of phosphate rock from Fosfatos du Bu-Craa S.A. were made to several countries in 1971.[17] Completion of production and shipping facilities appears certain to be

[10] Mining Magazine. Australian Phosphate. V. 127, No. 6, December 1972, p. 576.

[11] The British Sulphur Corp., Ltd. Mining and Beneficiation of Apatite Rock, at the Jacupiranga Mine, Brazil. No. 57, January–February 1972, pp. 37–40.

[12] Chemical Age International. Arad Phosphoric Plant To be Closed While Government Decides on the Future. V. 105, No. 2874, Nov. 24, 1972, p. 9.

[13] U.S. Embassy, Mexico City, Mexico. State Department Airgram A–425, July 19, 1972, pp. 4–5.

[14] Conversation with Mr. Daniel Cohen, Chef de la Delegation l'Office Cherifien des Phosphates, Paris, Mar. 14, 1973.

[15] Industrial Minerals. Mineroperu Takes Bayovar Phosphate and Potash. No. 57, June 1972, p. 34.

[16] U.S. Embassy, Dakar, Senegal. State Department Airgram A–15, Feb. 22, 1973, p. 1.

[17] Fertilizer International. Zen-Noh Sounds Fosbucraa's Capabilities. No. 38, October 1972, p. 2.

completed in 1972 to permit full-scale production of 3 million tons of phosphate rock in 1973. Zen-Noh, the Japanese National Federation of the Agriculture Cooperative Association, and Mitsubishi confirmed that they would receive shipments of Spanish Sahara phosphate rock in 1973.

Togo.—The Compagnie Togolaise des Mines du Bénin operated at its designed capacity of 2 million tons per year of phosphate rock. An additional investment of approximately $16 million in new mine and plant will be made to increase production to 2.6 million tons per year.[18]

Tunisia.—A new phosphoric acid plant in Gabes started production in February of 1972.[19] The plant is owned by Industries Chimiques Maghrébines, a Government-owned company in which French and Italian organizations have participating interests. The capacity is 120,000 tons of phosphoric acid (P_2O_5) per year. The plant utilizes Tunisian phosphate rock. The concept of building phosphoric plants at locations where raw materials are relatively cheap and shipping the acid to markets may be a trend that will show increasing acceptance in the future.

U.S.S.R.—The U.S.S.R. announced plans to increase production from the Kola apatite combine to 15.3 million tons per year of apatite concentrate by 1975.[20] Current total U.S.S.R. production is estimated to be about 25 million tons per year. In the past, the U.S.S.R. marketed large quantities of apatite in western and eastern European countries. It appears that exports have been restricted and the U.S.S.R. will consume most of its own production. With this development, Florida phosphate rock was imported into eastern Europe for the first time. Although it was assumed that the U.S.S.R. had very large reserves of economically recoverable phosphate rock, there are indications that the reserves are less than were estimated.

[18] U.S. Embassy, Lomé, Togo. State Department Airgram A-40, June 26, 1972, p. 1.
[19] European Chemical News. Heurtey Wins Acid Orders in Tunisia. V. 22, No. 546, Aug. 18, 1972, p. 13.
[20] The Fertilizer International. U.S.S.R. Plans To Increase Phosphate Rock Production. No. 38, August 1972, p. 5.

Table 15.—Phosphate rock: World production, by country

(Thousand short tons)

Country [1]	1970	1971	1972 [p]
North America:			
United States	[r] 38,739	38,886	40,831
Mexico	52	64	69
Netherlands Antilles [2]	[r] 158	172	66
South America:			
Argentina (guano)	(3)	1	[e] 1
Brazil	194	220	248
Chile (guano)	16	14	17
Colombia	13	11	7
Peru (guano)	55	25	[e] 25
Venezuela	34	29	[e] 33
Europe:			
France (phosphatic chalk)	29	21	36
Germany, West	76	66	83
Poland [e]	33	--	--
U.S.S.R.:			
Apatite (marketable concentrate, 39% P_2O_5)	12,460	12,840	13,230
Sedimentary rock (marketable concentrate, 19–25% P_2O_5)	10,500	11,000	11,600
Africa:			
Algeria	543	546	519
Egypt, Arab Republic of	[r] 790	786	[e] 780
Morocco	12,566	13,237	16,503
Senegal:			
Aluminum phosphate	144	162	183
Calcium phosphate	1,100	1,541	1,378
Seychelles Islands (guano) [2]	7	[e] 8	[e] 8
South Africa, Republic of	1,857	1,906	2,167
Southern Rhodesia	94	116	[e] 120
Togo	1,662	1,891	2,125
Tunisia	3,325	3,485	3,734
Uganda (apatite)	18	18	[e] 18
Asia:			
China, People's Republic of [e]	[r] 1,900	2,400	2,900
Christmas Island (Indian Ocean)	[r] 1,200	1,092	[e] 1,100
India:			
Apatite	17	12	13
Phosphate rock	165	256	239
Israel	1,280	843	1,219
Jordan	927	717	765

See footnotes at end of table.

Table 15.—Phosphate rock: World production, by country—Continued

(Thousand short tons)

Country [1]	1970	1971	1972 p
Asia—Continued			
Khmer Republic (formerly Cambodia)	3	--	--
Korea, North (apatite) e	r 270	300	330
Philippines:			
Guano	2	1	2
Phosphate rock	2	5	3
Syrian Arab Republic	--	7	83
Vietnam, North e	r 500	610	660
Oceania:			
Australia	16	11	e 11
Nauru Island	2,330	2,058	2,205
Ocean Island	558	683	555
Total	r 93,635	96,040	103,866

e Estimate. p Preliminary. r Revised.
[1] In addition to the countries listed Belgium, Indonesia, and Tanzania produce phosphate rock, and South-West Africa produces guano, but information is inadequate to make reliable estimates.
[2] Exports.
[3] Less than ½ unit.

TECHNOLOGY

A research program to attempt to solve the problem of disposing of waste phosphate slimes produced from beneficiating Florida and similar type phosphate rock was started.[21] The Florida Phosphate Council, representing 10 operating Florida companies, and the Federal Bureau of Mines are sponsoring the work with the cost of the program equally shared. The purpose of the program will be to develop an economically acceptable procedure to dewater slimes. If this can be accomplished, construction of earth dams to impound the slimes will not be necessary, and the slimes as well as the sand tailings can be used to reclaim mined land. The technology could be advantageously applied to North Carolina, Tennessee, and possibly Western State phosphate tailings.

Experimental studies by the Bureau of Mines to recover phosphates and metals from phosphate sludge generated from phosphate coating processes indicate that the process is technically feasible and economically attractive. Trisodium phosphate, zinc, and iron are recovered. After the sludge is dissolved in hydrochloric acid, the iron as ferric chloride is concentrated in isopropyl ether, zinc is extracted by 2-diethylhexyl phosphoric acid in kerosine, and phosphate is recovered by crystallization from the raffinate.

Additional details have been released about the Kellogg-Lopker phosphoric acid process after 4 years of continuously operating a 240-ton-per-day unit at Whitehaven, England.[22] The main points of interest about this process are that the feed phosphate rock does not have to be finely ground to assure unreacted P_2O_5 from passing through the process, and that the conditions in the reaction system can be controlled to the degree that optimum crystallization of gypsum can be quickly attained and maintained. The increased process flexibility with higher P_2O_5 throughput for equivalent equipment size has not been attained before according to the developers.

The Tennessee Valley Authority demonstrated several new fertilizer production procedures.[23] Some of these will reduce costs as well as permit their adoption by small operators. Briefly, they are a pipe reactor method of producing polyphosphate-enriched solutions; a method of coating urea with sulfur; and a two-stage ammoniating procedure to produce better ortho suspensions.

Nearly all phosphate rock contains fluorine, which is liberated as hydrogen fluoride during wet process phosphoric acid manufacture.[24] If hydrogen fluoride is permitted to escape into the atmosphere, it

[21] The Florida Times Union. Waste Clay Disposal Plan is Outlined. Oct. 17, 1972.
Dept. of the Interior News Release. Joint Research on Florida's Phosphate Waste Announced by Mines Bureau. Nov. 4, 1972.
[22] The British Sulphur Corp., Ltd. The Kellogg-Lopker Process. No. 62, November–December 1972, pp. 20–23.
[23] Ag-Chem. and Commercial Fertilizer. New TVA Procedures. V. 28, No. 2, February 1973, pp. 12–16.
[24] The British Sulphur Corp., Ltd. Fluorine. No. 57, January–February 1972, p. 60.

will create a health hazard. Several processes have been developed to purify fluosilicic acid after it is formed from hydrogen fluoride reacting with silica. APV-Mitchell, Ltd., developed technology for purifying fluosilicic acid and constructed a plant for Tohoku Hiryo KK at Akita, Japan, to produce 18% fluosilicic acid containing only 40–50 ppm P_2O_5. A new process has been developed in Romania to manufacture cryolite from fluorine liberated from phosphate rock during fertilizer manufacture. Fluosilicic acid is treated with sodium chloride to form sodium silicofluoride, reacted with sodium carbonate to produce a sodium fluoride solution, and reacted with sodium aluminate to form cryolite.

Lancy Laboratories of Zelienople, Pa., has devised a simple method of recovering phosphoric acid from waste aluminum plating solutions. A 28-foot-high column filled with Rohm & Haas ion exchange resin 410 can process up to 70 gallons of waste per day. Food-grade phosphoric acid is eluted from the column periodically with water. The system is expected to find broad application in the automobile and electronic industries.

The M. W. Kellogg Co. is making an engineering feasibility study for Multi Minerals, Ltd., of Canada, of a process that will produce phosphoric acid from monocalcium phosphate.[25] The Multi Minerals' process uses a regenerable ion-exchange resin to convert monocalcium phosphate into phosphoric acid.

Heurtey S.A. has announced a new wet process for the manufacture of phosphoric acid.[26] The process is of the hemihydrate/dihydrate type with the product acid taken at high concentration from the hemihydrate filtration stage. The process is an extension of the Singmaster and Breyer process and has been tested in a 1.5-ton-per-day pilot plant of Compagnie Française de l'Agote at Bassens.

A dry separator developed by the National Research Development Corp. and manufactured by Dryflo Separators, Ltd., of England, has shown it is capable of concentrating a number of minerals including phosphate rock by an entirely dry technique. The ore is fluidized above a porous deck, and as it is moved down a restricted trough, it is stratified according to its density or particle size. A movable splitter separates the fractions of different densities.

A number of research projects were underway at the Bureau of Mines Albany Metallurgy Research Center. These were (1) the recovery of fluorides from phosphate rock, (2) direct acidulation of phosphate ore with sulfuric acid, specifically, land-pebble phosphate ore from Florida to minimize slime formation, and (3) a study of processes to separate phosphate minerals from carbonates in western phosphate ores.

[25] The British Sulphur Corp., Ltd. Feed Phosphates. No. 60, July–August 1972, p. 48.

[26] The British Sulphur Corp., Ltd. Phosphoric Acid. No. 61, September–October 1972, p. 48.

Platinum-Group Metals

By J. M. West [1]

On the strength of a sharp upturn in consumption and growing anticipation that relatively large quantities of platinum-group metals might be needed within a few years for automotive exhaust control, platinum prices and world production posted significant increases in 1972. By the second quarter, U.S. dealers' prices for platinum and palladium had exceeded producers' prices. By early May, the dealers' price for iridium had rocketed from $145–$148 to $525 per ounce, settling back thereafter.

During the year, U.S. mine and secondary production declined 5% and 8%, respectively. However, refinery output of new metal, mainly from imported concentrates and matte, nearly doubled. The volume of metal refined on toll declined, mainly because of a drop in palladium recycling. Imports rose about 534,000 ounces; exports rose 134,000 ounces; stocks, including those on the Mercantile Exchange, rose 69,800 ounces; and sales rose 294,100 ounces. Overall sales were up 23% over those in 1971, with gains in sales of each platinum-group metal. The most significant increase was in sales of platinum, which rose 26%; iridium and ruthenium sales expanded greatly as a result of new chemical and petroleum uses.

World production of platinum metals rose 13% in 1972, owing to mine and refinery expansions in the Republic of South Africa and the U.S.S.R. Canadian production declined because of production cutbacks in the nickel industry, thereby limiting byproduct platinum output. The bulk of the South African production continued to be platinum, while the bulk of the U.S.S.R. production was palladium.

Concerns mounted in 1972 over whether established sources of new platinum could supply all the requirements for emission control devices that would be forthcoming with enforcement of new U.S. air quality standards. Producers and processors were active in reassuring potential consumers and Government agencies involved that adequate supplies could be made available if given adequate lead time to expand facilities. A number of provisional supply/purchase contracts were signed during the year by automakers. Major expansions were underway at yearend.

Legislation and Government Programs.—Government stockpile accumulations at

[1] Physical scientist, Division of Nonferrous Metals.

Table 1.—Salient platinum-group metals statistics

(Troy ounces)

	1968	1969	1970	1971	1972
United States:					
Mine production [1]	14,793	21,586	17,316	18,029	17,112
Value	$1,500,603	$2,094,607	$1,429,521	$1,359,675	$1,267,298
Refinery production:					
New metal	12,305	17,875	19,822	21,184	15,380
Secondary metal	329,455	371,659	350,176	278,175	255,641
Exports (except manufactures)	395,157	501,064	413,766	404,610	538,986
Imports for consumption	1,773,984	1,225,851	1,410,786	1,302,740	1,836,349
Stocks Dec. 31: Refiner, importer, dealer	802,711	1,077,478	765,332	856,784	896,677
Consumption	r 1,283,911	r 1,373,469	r 1,296,795	r 1,265,716	1,559,822
World: Production	3,393,749	3,431,155	4,238,956	4,084,110	4,613,431

r Revised.
[1] From crude platinum placers and byproduct platinum-group metals recovered largely from domestic copper ores.

yearend amounted to 1,254,994 troy ounces of palladium, 452,645 ounces of platinum, and 17,176 ounces of iridium. The iridium stocks, which were more than the 17,000 ounces set for the stockpile objective, contained 184 ounces of nonstockpile grade, and this was declared excess inventory available for disposal.

Table 2.—Government inventory of platinum-group metal, December 31, 1972

(Troy ounces)

Metal	National stockpile	Supplemental stockpile	Objective
Iridium	[1] 16,992	--	17,000
Palladium	[2] 507,314	747,680	1,300,000
Platinum	[3] 402,646	49,999	555,000

[1] Excludes 184 troy ounces nonstockpile grade material declared excess inventory.
[2] Includes 2,204 troy ounces nonstockpile grade material.
[3] Includes 2,566 troy ounces nonstockpile grade material.

DOMESTIC PRODUCTION

Domestic mine production of platinum-group metals declined 5% in quantity and 7% in value in 1972. Production from a platinum dredging operation at Goodnews Bay, in Southwestern Alaska, remained virtually unchanged. small amounts of placer gold were also recovered from this venture. The bulk of the platinum-group metals produced—chiefly palladium but with a significant amount of platinum—was recovered from copper refining, the platinum group-metals accompanying gold and other precious metals in the final stages of electrolytic treatment.

Refinery production of new platinum-group metals dropped 27%, with decreased outputs of every metal except iridium and osmium. Also secondary production declined 8% overall, mainly as a result of a sharp drop in secondary platinum refining. Ruthenium and osmium refining were also down.

Toll refining declined 6% in 1972 to a total of 1,361,623 troy ounces. Used material accounted for 94% of the total toll refined; the balance was virgin material, mostly from overseas sources. The United States continued to refine on toll a substantial amount of crude platinum or matte from Colombia, and some from Canada and the Republic of South Africa, although the total crude treated, 84,219 ounces, was down 64% from the 1971 amount. The total quantities treated on toll in 1972 and

Table 3.—New platinum-group metals recovered by refiners in the United States, by source

(Troy ounces)

Year and source	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
1968	6,302	5,358	454	95	90	6	12,305
1969	8,702	8,387	570	135	70	11	17,875
1970	8,036	r 10,322	1,261	r 129	64	10	r 19,822
1971:							
From domestic sources:							
Crude platinum; gold and copper refining	10,198	r 10,237	498	r 154	83	r 14	r 21,184
From foreign crude platinum	--	--	--	--	--	--	--
Total	10,198	r 10,237	498	r 154	83	r 14	r 21,184
1972:							
From domestic sources:							
Crude platinum; gold and copper refining	3,708	10,836	594	173	62	7	15,380
From foreign crude platinum	--	--	--	--	--	--	--
Total	3,708	10,836	594	173	62	7	15,380

r Revised.

1971 (in parentheses) were as follows, in troy ounces: Platinum, 842,470 (782,248); palladium, 455,000 (593,842); rhodium 47,419 (51,291); iridium, 9,468 (12,063); ruthenium, 5,635 (9,225); and osmium, 1,631 (4,169).

Table 4.—Secondary platinum-group metals recovered in the United States

(Troy ounces)

Year	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
1968	115,587	195,620	2,127	672	12,176	3,273	329,455
1969	126,822	227,763	2,250	208	11,743	2,873	371,659
1970	118,298	208,555	1,927	121	13,394	7,881	350,176
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

CONSUMPTION AND USES

Platinum-group metal sales to consuming industries rose 23% in 1972 to 1.56 million ounces. Increases were recorded for every metal as follows, in percent: Platinum, 26; palladium, 15; iridium, 143; osmium, 13; rhodium, 34; and ruthenium, 143. Most categories of consumption were higher, with uses in the chemical industry showing the most significant advance.

Sales of platinum rose to nearly 543,000 ounces, 42% of which went to the chemical industry. The chemical sales were 67% higher than in 1971. Platinum sales for petroleum refining dropped 32%, on the other hand, apparently because of a slowdown in new refinery construction. Sales to glass manufacturers declined, but manufacturers of electrical equipment used nearly 78% more platinum in 1972. Other uses also rose, including miscellaneous, which more than doubled.

Palladium sales rose 15%, with increases in nearly every category with the exception of electrical, which declined slightly. Dental and medical sales of palladium rose 53%. Electrical and chemical sales comprised 49% and 33%, respectively, of all palladium sales in 1972.

Iridium sales rose 143%, largely as a result of a sharp rise in sales to the petroleum industry for catalytic use. Petroleum accounted for only 3% of all iridium sales in 1971 but rose to 44% of sales in 1972. Sales for glassmaking were down sharply, apparently because of substitution by rhodium. Sales of osmium were 83% to the chemical industry, up from 70% in 1971. The pattern of rhodium sales was not much different than in 1971, except for the jump in sales for glass manufacture to 30% of total rhodium sales. Ruthenium sales boomed in chemical uses, rising nearly 300% in that category. Sales in 1972 were principally for chemical (75%) and electrical (12%) products.

Uses of platinum-group metals remained largely related to their unique catalytic properties, corrosion resistance, high electrical conductivity, reflectance, and physical strength under adverse conditions. One of the major uses was in the chemical industry for nitric acid production through the oxidation of ammonia employing a platinum-rhodium gauze. An estimate of the annual replacement costs—$9.7 million—for this market was published.[2] The petroleum refining industry was reported to be changing from use of monometallic platinum catalysts for reforming to a variety of new bimetallic catalysts. including platinum-rhenium, platinum-iridium, and possibly also platinum-germanium and platinum-indium.[3] The iridium catalyst development sparked an intensive search during the year for new sources of supply. Bimetallics were said to permit reforming at lower pressures and, as a result, gave longer catalyst life and greater octane yield. It was reported that bimetallics, while accounting for 30% of installed reforming capacity, were taking 75 to 80% of the replacement market in 1972.

Development of platinum-based automotive exhaust emission control catalysts continued during the year spurred by requirements of the Clean Air Act of 1970 and

[2] Burke, Donald P. Catalysts: Part 2: Chemical Catalysts. A Look at Eight Major Uses That Will Chew Up $90–$96 Million Worth of Catalysts This Year. Chem. Week, v. 111, No. 19, Nov. 8, 1972, pp. 35–45.

[3] Burke, Donald P. Catalysts: Part I: Petroleum Catalysts. A Comprehensive Look at a $168-Million/Year Business Headed for Spectacular Growth. Chem. Week, v. 111, No. 18, Nov. 1, 1972, pp. 23–33.

subsequent rulings under the Environmental Protection Agency's proposed standards. In pursuing efforts to meet the 1975 requirements, a variety of combinations of platinum and other potential conversion compounds in or on various supporting media were under test. Generally, a combination of platinum and palladium in a 5:2 ratio was found acceptable, with possibly a small addition of ruthenium or other platinum-group metal.[4] Estimates for the precious metal values involved in each unit ranged, generally, from $5 to $15. Overall cost per converter unit, containing coated ceramic pebbles or a ceramic honeycomb structure, was substantially higher owing to fabrication expense. Problems of use and maintenance of emission controls were outlined.[5] Most car manufacturers had made some commitment by yearend to purchase or manufacture platinum-based catalytic devices for their automobiles. Meanwhile, industry efforts were directed toward development of new types of engines or other means of propulsion that would be efficient but non-polluting.

Availability of a special palladium catalyst on a ceramic support was announced for use in controlling nitric acid pollution, especially from nitric acid plants but also from incinerators, etc., that may require controls when new standards are passed.[6] A platinum metals catalyst of undisclosed composition found use in small quantities for safety purposes in nuclear reactors by preventing hydrogen from reaching explosive concentrations.[7] A new rhodium plating process was announced for producing a highly reflective decorative finish,[8] and favorable electroplating properties of rhodium were described.[9] Alloy Metals, Inc., introduced a group of new silver-palladium-aluminum alloys for brazing titanium, beryllium, zirconium, and dissimilar metal assemblies.[10]

[4] Metals Week. Precious Metals: Platinum and Palladium In At Detroit. V. 43, No. 40, Sept. 29, 1972, p. 1.
[5] Chemical Week. EPA Clears the Air for Catalysts. V. 111, No. 19, Nov. 8, 1972, pp. 19–21.
[6] American Metal Market. Researcher Hails Palladium as Acid Pollutant Fighter. V. 79, No. 4, Jan. 6, 1972, p. 13.
[7] American Metal Market. Platinum Metals Said Performing Vital Nuclear Safety Function V. 79, No. 219, Nov. 30, 1972, p. 11.
[8] Metals Week. Elsewhere in Precious Metals. V. 43, No. 26, June 26, 1972, p. 6.
[9] American Metal Market. Properties of Rhodium Well-Suited for Electroplating. V. 79, No. 233, Dec. 20, 1972, p. 2a.
[10] American Metal Market. New Brazing Alloys Use Palladium. V. 79, No. 5, Jan, 7, 1972, p. 13.

Table 5.—Platinum-group metals sold to consuming industries in the United States

(Troy ounces)

Year and industry	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
1968	r 496,155	721,479	9,443	1,612	44,776	10,446	r 1,283,911
1969	r 531,703	758,738	14,218	1,472	50,144	17,194	r 1,373,469
1970	r 474,654	739,343	10,905	1,707	48,897	21,289	r 1,296,795
1971:							
Chemical	135,112	218,651	8,342	1,490	14,910	10,440	388,945
Petroleum	r 141,800	2,916	447	--	176	9	r 145,348
Glass	40,703	237	635	--	3,362	--	44,937
Electrical	51,940	431,505	2,619	--	9,084	4,351	499,499
Dental and medical	23,097	61,594	611	631	31	236	86,200
Jewelry and decorative	18,577	18,752	1,104	--	5,419	5,298	49,150
Miscellaneous	19,859	26,451	1,754	5	1,384	2,184	51,637
Total	r 431,088	760,106	15,512	2,126	34,366	22,518	r 1,265,716
1972:							
Chemical	225,895	292,710	12,429	1,997	15,358	40,984	589,373
Petroleum	96,424	14,499	16,725	--	149	--	127,797
Glass	26,970	2,250	58	--	13,923	--	43,201
Electrical	92,381	425,081	4,042	--	7,867	6,542	535,913
Dental and medical	30,462	94,274	376	374	48	441	125,975
Jewelry and decorative	20,655	19,375	1,565	14	6,593	1,810	50,012
Miscellaneous	50,089	27,835	2,559	12	2,157	4,899	87,551
Total	542,876	876,024	37,754	2,397	46,095	54,676	1,559,822

r Revised.

STOCKS

Stocks of platinum-group metals held by refiners, importers, and dealers increased 5% during the year, to 896,677 ounces. Increases in stocks of individual metals were as follows: Palladium, 28%; rhodium, 11%; and ruthenium, 1%. Platinum, iridium, and osmium stocks fell 12%, 9% and 86%, respectively. In addition, there were Government stocks of platinum, palladium, and iridium, as detailed earlier. (See p. 2.)

Table 6.—Refiner, importer, and dealer stocks of platinum-group metals in the United States, December 31

(Troy ounces)

Year	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
1968	322,932	393,882	15,127	2,402	55,097	13,271	802,711
1969	370,675	608,716	14,505	2,873	55,833	24,876	1,077,478
1970	346,852	332,726	13,366	1,868	47,767	22,753	765,332
1971	445,821	316,126	16,434	604	51,529	26,270	856,784
1972 [1]	392,435	405,793	14,987	82	56,967	26,413	896,677

[1] Stocks in the Mercantile Exchange depositories as of Dec. 29, 1972, were platinum, 49,900 troy ounces, and palladium, 20,400 troy ounces.

PRICES

The producers' price for platinum rose from $120–$125 to $130–$135 per ounce in July and remained at that level to the yearend. The palladium producers' price began the year at $36–$38 per ounce, rose several times reaching $60–$61 in November, and rose again in December to $68–$70 per ounce. Iridium rose about midyear from $150–$155 to $150–$195 per ounce. The producers' prices for the other platinum metals remained unchanged during the year, as follows: Osmium, $200–$225; rhodium, $195–$200; and ruthenium, $50–$55.

The dealers' prices for most of the platinum metals rose sharply during the year. After a brief decline from $113–$116 to $102–$105 in January, platinum rose to $155–$160 in August, declined to $137–$143 in September, rose again to $147–$149 in December, and dropped back to $139–$141 at yearend. The dealers' price for palladium declined from an initial $36–$37 to $30.50–$36 in the second quarter, then rose to $40.25–$42, and in August rose again to $60–$62. After a decline to $59–$61 in September through November, the price rose to $69–$72, and finished the year at $67–$68. Iridium began the year at $145–$148, jumped to $525 in early May on the strength of news about its use in a new catalytic product, then declined to $275–$300 at yearend. Ruthenium prices advanced from $45 to $58–$60 per ounce during the year. The dealers' price for osmium declined from $175–$200 to $150–$175; rhodium prices remained unchanged at $195–$198.

FOREIGN TRADE

Exports of platinum-group metals rose 33% in quantity and 55% in value compared with 1971 exports. Platinum exports alone rose 30% in quantity and 50% in value; platinum comprised about 77% of the total quantity and 85% of the total value of all platinum-group exports in 1972. Exports of other platinum-group metals rose 46% in quantity and 87% in value in 1972. Of all platinum-group metals exported, 91% went to five principal countries—Japan, West Germany, the United Kingdom, Belgium-Luxembourg, and Italy. The sharpest increase in exports was to Japan, the quantity rising from about 94,265 ounces in 1971 to 254,460 ounces in 1972. About 77% of the exports to Japan in 1972 consisted of unworked and partly worked but unrolled platinum metal. Exports to West Germany rose 33% in 1972; sharp declines were noted in exports to the United Kingdom and France.

U.S. imports of platinum-group metals rose 41% in quantity and 54% in value in 1972. Unwrought platinum and palladium imports rose 10% and 31%, respectively. Semimanufactured forms increased, platinum by 97% and palladium by 39%. Imports of all other platinum-group metals also rose sharply, with ruthenium more than doubling and iridium and rhodium up about 74% and 47%, respectively. About 91% of all imports came from four countries—the U.S.S.R., the United King-

Table 7.—U.S. exports of platinum-group metals, by country

Year and destination	Platinum and platinum-group ores and concentrates		Platinum and platinum-group metals, waste and scrap and sweepings		Platinum, unworked or partly worked, not rolled		Platinum, unworked or partly worked, rolled		Platinum-group metals unworked or partly worked, not rolled		Platinum-group metals unworked or partly worked, rolled	
	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)
1971:												
Argentina	--	--	--	--	353	$43	--	--	702	$30	--	--
Australia	--	--	--	--	510	58	--	--	1,422	51	--	--
Belgium-Luxembourg	3,472	$100	31,708	$1,220	--	--	--	--	5,024	171	--	--
Brazil	--	--	--	--	339	58	50	$6	947	42	154	$6
Canada	9,723	862	--	--	3,483	429	175	27	4,716	223	409	24
France	--	--	--	--	32,642	4,144	--	--	2,331	147	111	3
Germany, West	1,070	44	28,872	1,409	39,052	4,711	20	1	21,395	943	207	12
Hong Kong	--	--	--	--	--	--	901	104	33	2	81	4
Italy	--	--	--	--	223	30	--	--	9,374	492	1,337	21
Japan	631	44	--	--	58,199	6,612	14,562	1,660	15,800	922	5,073	183
Mexico	--	--	--	--	171	35	133	14	1,049	40	573	29
Netherlands	4	1	--	--	14,180	1,762	--	--	1,542	151	105	4
South Africa, Republic of	--	--	1,550	200	35	7	--	--	--	--	--	--
Switzerland	48	7	32	5	1,741	233	9	2	2,607	174	--	--
United Kingdom	--	--	73,063	5,184	1,882	222	44	9	3,454	159	1,758	52
Other	--	--	--	--	1,965	189	--	--	3,269	123	295	13
Total	14,948	1,058	135,225	8,018	154,775	18,533	15,894	1,823	73,665	3,670	10,103	351
1972:												
Argentina	--	--	--	--	--	--	--	--	126	19	--	--
Australia	--	--	--	--	630	74	--	--	2,312	123	40	2
Belgium-Luxembourg	2,100	77	41,133	1,936	324	52	--	--	1,560	101	--	--
Brazil	66	13	--	--	4,496	23	--	--	634	29	93	7
Canada	--	--	3,100	50	1,212	178	272	57	4,541	199	944	48
France	--	--	--	--	2,101	243	108	1	2,004	152	173	9
Germany, West	28,451	313	29,635	1,513	37,294	5,215	2,100	256	22,614	1,642	591	53
Hong Kong	--	--	--	--	33	6	1,003	107	176	5	23	1
Italy	--	--	--	--	56	8	--	--	17,270	636	1,895	37
Japan	--	--	--	--	195,159	26,928	12,772	1,662	42,757	3,025	3,772	190
Mexico	--	--	--	--	752	168	17	3	2,156	100	42	5
Netherlands	--	--	--	--	1,950	294	--	--	7,665	677	100	2
South Africa, Republic of	--	--	1,093	111	13	3	--	--	--	--	--	--
Switzerland	16	8	--	--	4,456	616	--	--	492	51	--	--
United Kingdom	1,049	71	27,042	2,190	18,461	2,058	3	1	3,627	178	1,923	52
Other	--	--	--	--	138	22	2	1	4,337	162	82	6
Total	31,682	482	102,003	5,800	267,075	35,888	16,277	2,088	112,271	7,099	9,678	412

Table 8.—U.S. imports for consumption of platinum-group metals

Year	Troy ounces	Value (thousands)
1970	1,410,786	$104,823
1971	1,302,740	93,674
1972	1,836,349	144,092

Table 9.—U.S. imports for consumption of platinum-group metals, by country

Year and country	Unwrought											
	Grains and nuggets (platinum)		Sponge (platinum)		Sweepings, waste and scrap		Iridium		Palladium		Rhodium	
	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)
1971:												
Argentina	--	--	--	--	112	$5	--	--	--	--	--	--
Australia	--	--	--	--	5,083	385	--	--	--	--	--	--
Austria	--	--	--	--	--	--	--	--	--	--	--	--
Belgium-Luxembourg	--	--	r 150	r $17	15,752	2,266	--	--	r 8,525	r $293	39	$7
Brazil	--	--	--	--	2,547	64	--	--	--	--	--	--
Canada	--	--	1,404	189	27,752	2,786	3,250	$416	16,200	528	--	--
Colombia	21,914	$1,910	113	1	1,897	260	--	--	--	--	2,932	114
Denmark	--	--	--	--	--	--	--	--	--	--	--	--
Finland	--	--	--	--	788	25	--	--	--	--	--	--
France	--	--	5	(1)	--	--	--	--	--	--	--	--
Germany, West	--	--	7,961	848	101	20	--	--	--	--	242	33
Italy	--	--	1,240	149	--	--	--	--	--	--	--	--
Japan	--	--	13,962	1,822	4,198	591	--	--	--	--	--	--
Mexico	--	--	--	--	4,624	104	--	--	--	--	--	--
Netherlands	--	--	--	--	--	--	--	--	--	--	--	--
New Zealand	--	--	--	--	51	3	--	--	--	--	--	--
Norway	3,485	369	528	59	--	--	--	--	3,890	129	--	--
Panama	--	--	--	--	50	2	--	--	--	--	--	--
Peru	--	--	--	--	67	7	--	--	--	--	--	--
South Africa, Republic of	3,109	128	111,743	12,064	6,356	447	3,000	279	37,113	1,330	335	64
Surinam	--	--	--	--	49	6	--	--	--	--	--	--
Sweden	--	--	--	--	3,179	292	--	--	--	--	--	--
Switzerland	--	--	--	--	--	--	--	--	458	15	--	--
U.S.S.R.	--	--	1,539	54	--	--	--	--	11,215	491	4,835	946
United Kingdom	6,450	763	191,822	21,679	2,425	214	8,043	1,213	143,482	5,133	25,381	4,816
Total	34,958	3,170	r 329,967	r 36,882	75,081	7,477	14,293	1,908	r 220,883	r 7,919	33,764	5,980

See footnotes at end of table.

Table 9.—U.S. imports for consumption of platinum-group metals, by country—Continued

Year and country	Unwrought											
	Grains and nuggets (platinum)		Sponge (platinum)		Sweepings, waste and scrap		Iridium		Palladium		Rhodium	
	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)
1972:												
Australia	--	--	--	--	7,378	$677	--	--	974	$40	--	--
Belgium-Luxembourg	--	--	220	$24	15,697	2,290	--	--	--	--	--	--
Botswana	--	--	--	--	320	23	--	--	--	--	--	--
Brazil	--	--	1,005	126	--	--	--	--	--	--	122	$20
Canada	--	--	1,482	219	12,678	1,211	840	$111	12,196	588	428	74
Colombia	14,820	$1,501	600	72	2,315	290	--	--	--	--	--	--
Costa Rica	--	--	247	33	953	63	--	--	--	--	247	33
Finland	--	--	--	--	692	113	--	--	--	--	--	--
Germany, West	313	48	7,298	944	2,905	310	138	24	1,000	35	11	2
Ghana	--	--	--	--	90	8	--	--	--	--	--	--
Japan	15,266	2,016	9,500	1,269	14	3	--	--	26,906	1,629	3,213	431
Malawi	--	--	500	57	--	--	--	--	--	--	--	--
Mexico	--	--	269	46	13,482	1,299	--	--	--	--	6	1
Netherlands	--	--	--	--	563	73	50	9	520	40	--	--
Netherlands Antilles	--	--	--	--	22	4	--	--	--	--	--	--
New Zealand	--	--	--	--	18	1	--	--	--	--	--	--
Norway	3,982	486	--	--	--	--	--	--	4,080	165	--	--
Panama	161	20	253	34	45	2	--	--	--	--	19	4
South Africa, Republic of	1,575	202	100,264	11,805	8,673	603	3,706	539	111,620	4,345	2,524	492
Sweden	--	--	--	--	2,807	258	--	--	--	--	--	--
Switzerland	--	--	--	--	--	--	--	--	--	--	1	(1)
Turkey	--	--	--	--	--	--	--	--	--	--	--	--
U.S.S.R.	19,902	2,695	2,484	352	--	--	--	--	28,914	1,373	4,018	767
United Kingdom	2,265	286	226,021	27,641	6,528	368	20,093	3,355	102,845	4,714	36,789	6,911
Venezuela	--	--	--	--	30	4	--	--	--	--	--	--
Total	58,284	7,254	350,143	42,622	75,210	7,600	24,827	4,038	289,055	12,929	47,378	8,735

Year and country	Unwrought				Semimanufactured								Total	
	Ruthenium		Other platinum-group metals		Platinum		Palladium		Rhodium		Other platinum-group metals			
	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)	Troy ounces	Value (thousands)
1971:														
Argentina	--	--	--	--	--	--	--	--	--	--	--	--	112	$5
Australia	--	--	--	--	--	--	--	--	--	--	16	$2	5,099	387
Austria	--	--	--	--	--	--	1,612	$55	--	--	--	--	1,612	55
Belgium-Luxembourg	--	--	--	--	--	--	--	--	--	--	--	--	24,466	2,583
Brazil	--	--	--	--	--	--	--	--	--	--	--	--	2,547	64
Canada	--	--	23	$3	657	$70	2,079	75	--	--	--	--	51,365	4,067
Colombia	--	--	--	--	--	--	--	--	--	--	--	--	26,856	2,285
Denmark	--	--	--	--	375	42	400	13	--	--	--	--	775	55
Finland	--	--	--	--	--	--	--	--	--	--	--	--	788	25

France	--	--	--	--	--	--	--	--	--	--	--	--	5	(1)
Germany, West	--	--	--	--	1,299	175	--	--	81	$13	--	--	9,684	1,089
Italy	--	--	--	--	--	--	--	--	--	--	--	--	1,240	149
Japan	--	--	965	106	4,541	680	--	--	--	--	504	89	24,170	3,288
Mexico	--	--	--	--	--	--	--	--	--	--	--	--	4,624	104
Netherlands	--	--	--	--	150	16	631	21	--	--	--	--	781	37
New Zealand	--	--	--	--	--	--	--	--	--	--	--	--	51	3
Norway	--	--	--	--	2,700	263	1,950	64	--	--	--	--	12,553	884
Panama	--	--	--	--	--	--	--	--	--	--	--	--	50	2
Peru	--	--	--	--	--	--	--	--	--	--	--	--	67	7
South Africa, Republic of	--	--	--	--	1,966	230	2,050	72	--	--	--	--	165,672	14,614
Surinam	--	--	--	--	--	--	--	--	--	--	--	--	49	6
Sweden	--	--	--	--	--	--	888	176	--	--	--	--	4,067	468
Switzerland	--	--	--	--	12	(1)	--	--	--	--	--	--	470	15
U.S.S.R.	--	--	--	--	67,702	7,011	321,694	10,889	643	125	--	--	407,628	19,516
United Kingdom	28,063	$1,222	14,049	1,958	26,404	2,988	111,161	3,833	174	31	1,055	116	558,009	43,966
Total	28,063	1,222	15,037	2,067	105,806	11,475	442,465	15,198	898	169	1,575	207	1,302,740	93,674
1972:														
Australia	--	--	--	--	--	--	--	--	--	--	--	--	8,352	717
Belgium-Luxembourg	--	--	--	--	--	--	--	--	--	--	--	--	15,917	2,314
Botswana	--	--	--	--	--	--	--	--	--	--	--	--	320	23
Brazil	--	--	--	--	--	--	--	--	--	--	--	--	1,127	146
Canada	1,000	40	8,500	355	1,165	124	1,316	54	--	--	--	--	39,605	2,776
Colombia	--	--	6,000	523	1,800	213	--	--	--	--	--	--	25,535	2,599
Costa Rica	--	--	--	--	--	--	--	--	--	--	--	--	1,447	129
Finland	--	--	--	--	--	--	--	--	--	--	--	--	692	113
Germany, West	--	--	--	--	1,642	189	5,840	311	16	3	513	78	19,676	1,944
Ghana	--	--	--	--	--	--	--	--	--	--	--	--	90	8
Japan	--	--	37,022	4,913	12,550	1,726	7,404	372	--	--	--	--	111,875	12,359
Malawi	--	--	--	--	--	--	--	--	--	--	--	--	500	57
Mexico	--	--	1,912	46	--	--	--	--	--	--	--	--	15,669	1,392
Netherlands	--	--	295	44	--	--	--	--	--	--	--	--	1,428	166
Netherlands Antilles	--	--	--	--	--	--	--	--	--	--	--	--	22	4
New Zealand	--	--	--	--	--	--	--	--	--	--	--	--	18	1
Norway	--	--	--	--	4,255	452	11,044	308	--	--	--	--	23,361	1,411
Panama	--	--	--	--	--	--	--	--	--	--	--	--	478	60
South Africa, Republic of	2,635	110	400	52	5,500	693	300	15	--	--	500	27	237,697	18,883
Sweden	--	--	--	--	--	--	--	--	--	--	--	--	2,807	258
Switzerland	--	--	--	--	--	--	2,098	118	--	--	--	--	2,099	118
Turkey	--	--	--	--	1,629	167	--	--	--	--	--	--	1,629	167
U.S.S.R.	--	--	36,299	5,272	147,008	15,493	494,198	18,137	3,121	484	320	135	736,264	44,708
United Kingdom	57,556	2,452	12,991	929	32,411	3,812	90,974	3,173	289	56	949	38	589,711	53,735
Venezuela	--	--	--	--	--	--	--	--	--	--	--	--	30	4
Total	61,191	2,602	103,419	12,134	207,960	22,869	613,174	22,488	3,426	543	2,282	278	1,836,349	144,092

r Revised.
[1] Less than ½ unit.

Note.—In addition, platinum content from materials n.e.s.: 1971, 85,170 troy ounces ($7,350,966); 1972, 45,229 troy ounces ($3,222,233); and platinum content from precious metal ores: 1971, 133 troy ounces ($19,262); 1972, 10,606 troy ounces ($952,980).

dom, the Republic of South Africa, and Japan. Imports from the U.S.S.R. were up 81% from those in 1971 and consisted mainly of palladium (67%) and platinum (20%) semimanufactures. Unwrought metals were also imported from the U.S.S.R. Imports of platinum-group metals from Japan were up nearly 5 times the 1971 quantities. Imports from the Republic of South Africa rose 43%, while those from the United Kingdom rose only 6%.

WORLD REVIEW

World production of platinum-group metals rose 13% in 1972, chiefly because of expansions in the Republic of South Africa and in the U.S.S.R. Platinum producers were buoyed by several large contracts to supply platinum metals to automobile manufacturers for exhaust control. Although contracts generally had some kind of escape clause to limit deliveries if metals were not needed, producers had adequate assurance to proceed with expansion plans. Most of the activity was in the area of the Merensky Reef, Republic of South Africa, and the Norilsk area, U.S.S.R. An estimated 80 to 90% of Soviet production continued to come from the Norilsk and Petsamo areas of the U.S.S.R., where copper and nickel ores contain a small fraction of an ounce per ton of platinum-group metals in the approximate following proportions: 30% platinum, 60% palladium, and the remaining 10% in ruthenium, rhodium, iridium, and osmium. Deposits in the Republic of South Africa, on the other hand, were estimated to contain the following proportions: 64% platinum, 24% palladium, 5% ruthenium, 4% rhodium, 2% iridium, and less than 1% osmium in ores generally averaging 0.15 ounce of platinum metals per ton. Nickel, copper, and a little gold were also present in the South African ores.

Philippine production contained in nickel-cobalt concentrate produced by Acoje Mining Co. at Santa Cruz, Zambales Province, Luzon, rose sharply in 1972 and totaled about 8,000 ounces, two-thirds of which was palladium. Concentrates were shipped to Japan for refining. Finland continued to produce byproduct platinum from the Outokumpu Oy copper smelter. The International Mining Corp. operated dredges in the Choco and Nariño districts of Colombia and produced about the same quantity of platinum as reported in 1971. Canadian production declined in 1972 owing to a cutback in nickel production because of oversupply. Most production came from the Sudbury district as a byproduct of nickel-copper operations of International Nickel Co. of Canada Ltd. and Falconbridge Nickel Mines Ltd. The bulk of the platinum was refined at Acton in the United Kingdom, and at Newark, N.J.

South Africa, Republic of.—South African production resumed its upward trend after dropping sharply in 1971 because of depressed markets. With the renewed assurance that platinum catalyst demands would greatly expand sales, producers had a variety of projects underway. Rustenburg Platinum Mines Ltd. and Impala Platinum Ltd. completed smelter and mine expansions begun in 1970 and planned additional improvements. Rustenburg's New Wadeville refinery to extract platinum-group metals from matte was scheduled for operation in 1974, and thereafter only a small portion of the matte product would be exported. Ore reserves of potential new mines in four areas held by Rustenburg's parent company, Johannesburg Consolidated Investment Co. Ltd. (JCI), were as follows: Swartkop, 300 million metric tons, 70–80% payable; Derbroken, 100 million tons, 70–80% payable; unnamed property on updip side of the Atok mine, 200 million tons, 30% payable; and Potgietersrust, 50 million tons (opencast). Reserves of other companies were generally adequate for planned expansions, although additional shafts and increased milling and refining capacities were expected to be required. Estimated mine capacities and production rates in 1972 were as follows, in thousand ounces:

Mine	Capacity (yearend)		Production	
	Platinum-group metals	Platinum	Platinum-group metals	Platinum
Rustenburg, including Union section	1,700	1,200	800	500
Impala (Bafokeng)	600	350	500	350
Western Plats (began in March 1971)	135	100	135	100
Atok	18	11	18	11
Total	2,453	1,661	1,453	961

The Merensky Reef platinum deposits and platinum processing in the Republic of South Africa were described.[11] Installed annual capacity of the industry was estimated at 1.5 million troy ounces of platinum and 1 million ounces of other platinum-group metals (mainly palladium). The largest of four active producers was Rustenburg Platinum Mines Ltd., with installed capacity of 1.7 million ounces and an expansion program underway. The main concentration of values in the Merensky Reef was confined to a persistent 3/4-inch chromite-rich platiniferous band. Ores were concentrated at Waterval and Klipfontein and concentrates were smelted to matte at Waterval. Future production based on existing expansion plans in September 1972 was, as follows, in thousand ounces of platinum-group metals:

Mine	1973	1974	1975	1980
Rustenburg	1,700	2,000	2,200	3,000
Impala	600	850	950	1,500
Western Plats	185	235	285	500
Atok	18	40	290	350
Eland	--	(1)	300	475
Total	2,503	3,125	4,025	5,825

1 Possibly some production in late 1974.

Labor shortages and limited local short-term financing loomed as problems to expanded production. It was estimated that 10,000 workers were needed per 300,000 ounces of platinum production. Competition with South African gold producers for labor was a factor. About 300 million South African rands ($360 million) in capital financing was estimated to be needed for each 1-million-ounce expansion over the 1972 production levels.

Marketing of South African production continued through established sales channels in Europe, Japan, and the United States. Output of Rustenburg Platinum

[11] Engineering & Mining Journal. South Africa: An Explosive Mineral Potential. V. 173, No. 11, November 1972, pp. 122–123, 178–180.

Table 10.—Platinum group metals: World production by country [1]

(Troy ounces)

Country	1970	1971	1972 p
Canada: Platinum and other platinum group metals	482,428	475,169	399,000
Colombia: Placer platinum	26,358	25,610	e 26,000
Ethiopia: Placer platinum	273	217	248
Finland: Platinum-group metals recovered from domestic copper ores by copper refinery e	645	600	650
Japan:			
Palladium from refineries	4,610	5,375	5,659
Platinum from refineries	3,296	3,451	4,240
Philippines:			
Palladium metal	878	1,756	4,810
Platinum metal	352	703	2,712
South Africa, Republic of:			
Platinum-group metals from platinum ores e	1,500,000	1,250,000	1,800,000
Osmiridium from gold ores (sales) e	2,800	3,200	3,000
U.S.S.R.: Placer platinum and platinum-group metal recovered from platinum-nickel-copper ores	2,200,000	2,300,000	2,350,000
United States: Crude placer platinum and byproduct metals recovered largely from domestic gold and copper refining	17,316	18,029	17,112
Total	4,238,956	4,084,110	4,613,431

e Estimate. p Preliminary.
1 Excludes refined platinum production from Norway, which is derived from imported raw materials, chiefly (if not wholly) of Canadian origin, in order to avoid double counting.

Mines Ltd. was marketed by Johnson Matthey & Co. Ltd. and Engelhard Minerals & Chemicals Corp.; Impala Platinum Ltd. sold through Ayrton Metals Ltd.; Western Platinum Ltd. sales were handled by Falconbridge Nickel Mines Ltd.; and Atok Investments (Pty) Ltd's limited production was sold through the Anglo-Vaal Group. Stocks of platinum-group metals on hand in South Africa were estimated about 500,000 ounces in September 1972.

TECHNOLOGY

Interest in platinum technology in 1972 centered around development of viable catalytic exhaust emission systems for automobiles to enable new production models to meet the requirements of the Clean Air Act of 1970, as amended. Problems of configuration, support mechanisms, most effective and economic platinum metal compositions, durability and location of units with respect to other exhaust components were studied.[12] Generally, a composition of platinum and palladium on a ceramic honeycomb support structure was found to be effective and promising. General Motors Corp. reportedly was testing two dual catalytic systems, one of which would use a combination of 0.1 ounce of platinum and 0.04 ounce of palladium per automobile.[13] Ruthenium was also expected to be incorporated in smaller quantities. With the expected use of platinum catalytic devices will come increased demand for unleaded gasolines, because lead in existing fuels "poisons" the catalysts rendering the units ineffective. A consequence was that platinum metals would also be needed in greater quantities for reforming and other refining operations to increase gasoline extraction and octane ratings.

As in past years, Johnson, Matthey & Co. Ltd., of London, published its quarterly, Platinum Metals Review, describing research and developments in the platinum metals. Among the more interesting reports in 1972 were those on "High Pressure Research on Palladium-Hydrogen Systems" (January, pp. 10–15), "Platinum Catalysts in Lead-Free Gasoline Production" (April, pp. 42–47), "Automobile Emission Control Systems" (July, pp. 74–86), and a review of the "Fifth International Congress on Catalysis" (October, pp. 138–139). Unique catalytic properties were noted when platinum metal halides were reacted with aromatic radical-ions such as sodium napthalide and related species in a study of the products of such reactions.[14] As an example, platinum prepared in this way could be dissolved readily in hot 68% nitric acid. Outstanding activity was shown by the platinum-group metals as catalysts in the oxidation of organic compounds by molecular oxygen. Electrostatic and magnetic susceptibility properties were also changed.

Occurrence and distribution of platinum, palladium, and rhodium in the Stillwater Complex of Montana was described.[15] Values generally were too low to have economic significance. Existence of a platinum indicator flower, identified as Eritrichium chamissonis, was reported in Alaska after a study of its association with ultrabasic rocks on Red Mountain, believed to be the source of platinum deposits in Goodnews Bay, Alaska.[16] The flower was found to be a useful prospecting guide to the soil overlying deposits. These soils were favored by the plant owing to release of leachable cations in the process of weathering, but the plant itself did not appear to take up platinum.

Platinum-group metals were recovered with other precious metals from electronic scrap in experiments conducted by the Bureau of Mines at its Salt Lake City Metallurgy Research Center[17] and its Boulder City Metallurgy Research Laboratory.[18]

[12] Work cited in footnote 5.
[13] Work cited in footnote 4.
[14] Booth, D. J., D. Bryce-Smith, and A. Gilbert. Novel Procedures for the Preparation of Platinum and Other Metals in Forms Having Abnormally High Catalytic Activity. Chem. & Ind. (London), No. 17, Sept. 2, 1972, pp. 688–689.
[15] Page, Norman J., Leonard B. Riley, and Joseph Haffty. Vertical and Lateral Variation of Platinum, Palladium, and Rhodium in the Stillwater Complex, Montana. Econ. Geol., v. 67, No. 7, November 1972, pp. 915–923.
[16] Rudolph, W. W. and J. R. Moore. A New and Strange Prospecting Guide. Alaska Construction & Oil Report, February 1972, pp. 40–41.
[17] Dannenberg, R. O., J. M. Maurice, and G. M. Potter. Recovery of Precious Metals From Electronic Scrap. BuMines RI 7683, 1972, 19 pp.
[18] Sullivan, T. A., R. L. de Beauchamp, and E. L. Singleton. Recovery of Aluminum, Base, and Precious Metals From Electronic Scrap. BuMines RI 7617, 1972, 16 pp.

Potash

By Donald E. Eilertsen [1]

Moderate production, higher prices, record consumption and imports, and unusually large exports were some of the highlights of marketable potassium salts in the United States in 1972. Imports of potash were larger than domestic production for the second consecutive year. The Province of Saskatchewan, Canada, continued its production and pricing regulations for the third consecutive year. These regulations have been largely responsible for higher worldwide potassium muriate prices since the low prices of 1969.

Table 1.—Salient statistics on potassium salts

(Thousand short tons and thousand dollars)

Item	1968	1969	1970	1971	1972
United States:					
Production of potassium salts, marketable	4,769	4,918	4,853	4,543	4,738
Approximate K_2O equivalent	2,722	2,804	2,729	2,587	2,659
Value	75,664	73,572	98,123	100,527	106,680
Sales of potassium salts by producers	5,091	5,340	4,703	4,578	4,653
Approximate K_2O equivalent	2,913	3,069	2,669	2,592	2,618
Value at plant	81,620	78,062	92,373	102,099	104,680
Average value per ton	16.03	14.62	19.64	22.30	22.50
Exports of potassium salts [1]	1,303	1,233	966	1,033	1,353
Approximate K_2O equivalent [1]	735	700	544	564	764
Value [1]	38,353	33,061	28,473	35,323	45,858
Imports for consumption of potassium salts [1]	3,644	3,926	4,403	4,672	4,979
Approximate K_2O equivalent [1]	2,166	2,332	2,605	2,766	2,961
Value [1]	71,910	60,703	94,734	111,844	119,666
Apparent consumption of potassium salts [2]	7,432	8,033	8,140	8,217	8,279
Approximate K_2O equivalent	4,344	4,701	4,730	4,794	4,815
World: Production, marketable:					
Approximate K_2O equivalent	17,867	19,198	20,013	21,817	22,465

[1] Excludes potassium chemicals and mixed fertilizers.
[2] Measured by sold or used plus imports minus exports.

DOMESTIC PRODUCTION

Domestic production of marketable potassium salts consisting of potassium chlorides (muriates), potassium-magnesium sulfate, potassium sulfate, and mine-run salts in terms of potassium monoxide (K_2O) equivalent was 2.8% larger than in 1971. Production has ranged from 2.6 to 2.8 million tons of K_2O annually since 1968; record production of 3.3 million tons of K_2O production occurred in 1966. Eleven producers in three States produced marketable potassium salts in 1972. The companies were AMAX Chemical Corp., Duval Corp., International Minerals & Chemical Corp. (IMC), Kerr-McGee Corp., National Potash Co., Potash Co. of America, Division of Ideal Basic Industries, Inc., and Teledyne Potash (formerly United States Potash & Chemical Co.) all in New Mexico; Great Salt Lake Minerals & Chemicals Corp., Kaiser Aluminum & Chemical Corp., and Texas Gulf, Inc. (formerly Texas Gulf Sulphur Co.) in Utah; and Kerr-McGee Corp. (American Potash Division), in California.

New Mexico accounted for 86.3% of the national production of marketable K_2O in 1972. The average grade of mined ore declined from 17.3% K_2O in 1971 to 16.3% K_2O in 1972, the lowest in many years.

[1] Physical scientist, Division of Nonmetallic Minerals (retired).

Table 2.—Marketable potassium salts produced and sold or used in the United States, in 1972, 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 1972:						
Muriate of potash, 60% K_2O minimum:						
Standard	879	536	17,505	975	595	19,634
Coarse	494	302	10,839	540	330	11,833
Granular	390	237	8,911	383	233	8,820
Potassium sulfate	182	93	7,342	204	105	8,220
Other potassium salts [2]	446	175	8,984	525	203	10,549
Total [3]	2,391	1,344	53,580	2,627	1,467	59,057
July-December 1972:						
Muriate of potash, 60% K_2O minimum:						
Standard	888	541	17,962	822	502	16,705
Coarse	483	295	10,216	401	246	8,478
Granular	370	225	7,750	297	181	6,199
Potassium sulfate	212	109	9,170	168	87	7,315
Other potassium salts [2]	395	144	8,001	336	136	6,927
Total [3]	2,347	1,315	53,100	2,026	1,150	45,623
Grand total	4,738	2,659	106,680	4,653	[3] 2,618	104,680

[1] Derived from reported value of "Sold or used."
[2] Figures for chemical and soluble muriates and manure salts are included with potassium-magnesium sulfate.
[3] Data may not add to totals shown because of independent rounding.

Table 3.—Crude potassium salts produced, and marketable salts produced and sold or used in New Mexico

(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
1971:								
January-June	8,293	1,453	2,136	1,210	46,195	2,484	1,404	54,462
July-December	7,824	1,338	1,894	1,081	40,494	1,617	914	34,863
Total	16,117	[3] 2,792	4,030	2,291	86,689	4,101	[3] 2,317	89,325
1972:								
January-June	8,718	1,460	2,128	1,187	47,018	2,336	1,294	51,400
July-December	8,567	1,411	1,994	1,108	44,097	1,753	991	38,461
Total	17,285	2,871	4,122	[3] 2,296	91,115	4,089	2,285	89,861

[1] Sylvite and langbeinite.
[2] Derived from reported value of "Sold or used."
[3] Data may not add to totals shown because of independent rounding.

Potash producers in the United States had about 3.5 million tons of K_2O plant capacity in 1972 of which New Mexico accounted for approximately 2.8 million tons. Based on these figures, the potash industry of the United States operated at 76.5% capacity in 1972, and New Mexico producers operated at 82.4% capacity. The United States consumes much more potash than it has plant capacity. Consequently, large quantities of potash are imported to meet demand.

Texas Gulf, Inc., resumed potassium chloride production at its Cane Creek operation at Potash, Utah, in March after converting from underground mechanized mining to a combination of solution mining and solar evaporation. The mixed salts, consisting of potassium and sodium chlorides, are separated in the company's original refinery. This is the first potash solution mining operation in the United States; the only other similar operation is in Saskatchewan, Canada.

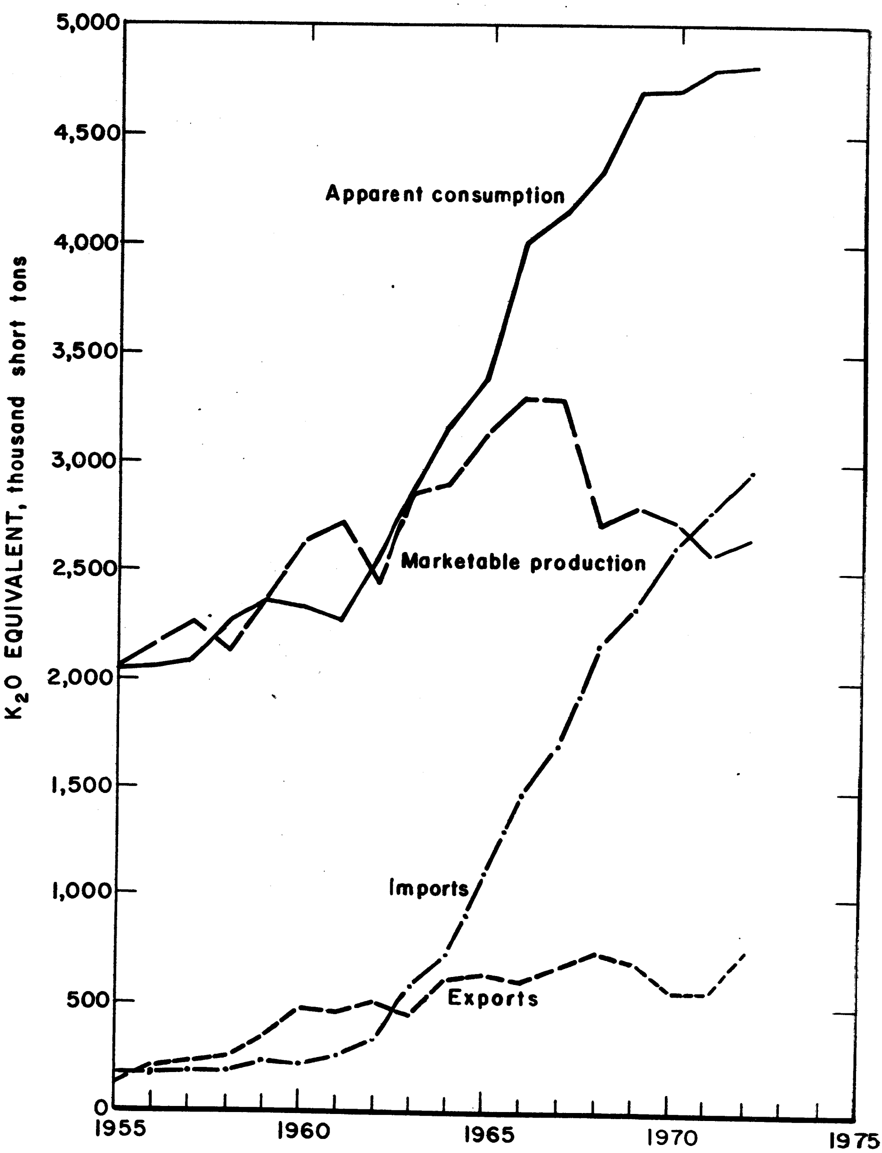

Figure 1.—Marketable production, apparent consumption, exports, and imports of potassium salts measured in K_2O equivalent.

Searles Lake Chemical Corp., a subsidiary of Occidental Petroleum Corp., continued preparations to extract potassium sulfate, borax products, and soda ash from brines at Searles Lake, Calif.

Approximately 178,000 tons of liquid potassium hydroxide, caustic potash, 88% to 92% pure, was produced from chemical-grade potassium muriate in the United States in 1972.

CONSUMPTION AND USES

Apparent consumption of 8.27 million tons of potassium salts (4.81 million tons of K_2O), measured by sales plus imports minus exports, continued the trend of establishing new records. The United States, as usual, continued to be the world's largest consumer of potash.

According to the Potash Institute of North America, deliveries of domestic and imported potassium salts for agricultural and chemical purposes in the United States were 4.65 million tons of K_2O equivalent. Of this quantity, 4.38 million tons of K_2O (94.2%) was agricultural potash, and 0.27 million tons (5.8%) was chemical potash. Illinois, Iowa, Indiana, Minnesota, and Ohio were the largest recipients of potash for agriculture, and together accounted for 38.2% of this total. New York, Illinois, Alabama, Delaware, and Kentucky accounted for 72.4% of the potash delivered for chemicals.

A large use for chemical-grade potassium chloride is as raw material for producing electrolytic potassium hydroxide (caustic potash) and byproduct chlorine. Caustic potash has direct applications and also large usage as starting material for producing many other chemicals for a variety of uses.

Table 4.—Deliveries of potash salts in 1972, by State of destination

(Short tons K_2O equivalent)

Destination	Agricultural potash	Chemical potash	Destination	Agricultural potash	Chemical potash
Alabama	129,045	41,089	Nebraska	38,573	501
Arizona	712	1,459	Nevada	61	719
Arkansas	78,072	479	New Hampshire	278	65
California	62,197	4,002	New Jersey	13,756	1,554
Colorado	10,065	43	New Mexico	4,004	151
Connecticut	3,188	316	New York	94,135	64,142
Delaware	29,521	22,322	North Carolina	120,735	819
Florida	230,333	907	North Dakota	12,703	9
Georgia	227,590	2,350	Ohio	252,644	8,363
Hawaii	24,882	--	Oklahoma	25,900	293
Idaho	10,273	--	Oregon	12,660	1,464
Illinois	476,308	48,942	Pennsylvania	54,360	5,406
Indiana	305,198	7,840	Rhode Island	1,796	441
Iowa	343,428	8,994	South Carolina	84,487	416
Kansas	37,493	2,296	South Dakota	8,406	25
Kentucky	95,252	17,885	Tennessee	110,474	89
Louisiana	50,228	715	Texas	236,588	9,043
Maine	12,432	98	Utah	553	276
Maryland	59,833	1,425	Vermont	5,402	--
Massachusetts	3,033	649	Virginia	73,696	544
Michigan	140,944	1,214	Washington	29,141	2,320
Minnesota	297,571	2,263	West Virginia	3,910	1,950
Mississippi	135,309	1,000	Wisconsin	216,025	1,185
Missouri	211,838	2,151	Wyoming	1,539	374
Montana	4,122	56	Total	[1] 4,380,693	[2] 268,644

[1] Distribution of K_2O—1,292,732 tons as standard muriate, 1,512,042 tons as coarse muriate, 1,106,077 tons as granular muriate, 281,300 tons as soluble muriate, and 188,542 tons as sulfates.
[2] Distribution of K_2O—188,122 tons as muriate, 76,830 tons as soluble muriate, and 3,692 tons as sulfates.

Source: Potash Institute of North America, Atlanta, Ga.

STOCKS

At yearend, producers' stocks totaled 881,000 tons of marketable potassium salts containing 469,000 tons of K_2O equivalent —9.6% more K_2O than in 1971. Yearend stocks of imported potassium salts were not available.

Table 5.—Yearend stocks of marketable potassium salts in the United States

(Thousand short tons)

Year	Number of producers	Stocks, Dec. 31: Gross weight	Stocks, Dec. 31: K_2O equivalent
1968	13	1,175	676
1969	12	723	392
1970	13	875	454
1971	11	796	428
1972	11	881	469

TRANSPORTATION

Freight rates were obtained for shipments of muriate of potash (KCl) from points of origin in the United States and Canada to various destinations in the United States. One analysis, based on a minimum weight of 40 tons of KCl per car (table 6), indicated that U.S. producers would have a shipping cost advantage and could ship KCl at lower freight rates from their plants to points south of a zigzag line extending from the northeastern corner of Idaho, to Billings, Mont., North Platte, Nebr., Des Moines, Iowa, St. Louis, Mo., Madison, Wis., Chicago, Ill., Indianapolis, Ind., Lansing, Mich., Columbus, Ohio, Harrisburg, Pa., Richmond, Va., Baltimore, Md., Syracuse, N.Y., and Concord, N.H.; whereas Canadian producers would have the advantage in shipping to points north of the same line.

Another analysis indicated that New Mexico producers could ship KCl advantageously to points south of a zigzag line extending from Seattle, Wash., to Portland, Oreg., Pocatello, Idaho, a point a few miles north of Casper, Wyo., then to North Platte, Nebr., Des Moines, Iowa, Madison, Wis., Chicago, Ill., Lansing, Mich., Indianapolis, Ind., Columbus, Ohio, Richmond, Va., Baltimore, Md., Harrisburg, Pa., Syracuse, N.Y., and Concord, N.H. For several destinations, the freight rates were lower for larger minimum weights per car. Canadian producers would have the lower rates for KCl shipped to points north of this line.

The study also revealed that considerable KCl is transported by rail and truck from certain Saskatchewan producers to Northgate, N. Dak., for reshipment by train to various destinations in the United States. For a minimum weight of 40 tons per car, the freight rate to Northgate from Saskatchewan was quoted at $16.05 per ton. However, for minimum weights of 50 tons in box cars or 60 tons in covered hopper cars, the rate was $14.77 per ton. Large tonnages of potassium muriate from Saskatchewan were reportedly transported

Table 6.—Freight rates per short ton of muriate of potash (KCl) from producing centers to various destinations, minimum weight 40 short tons of KCl per car

Destination	From Carlsbad, N. Mex.	From Trona, Calif.	From Wendover, Utah	From Potash, Utah	From Saskatchewan, Canada
Atlanta, Ga	$19.89	$21.78	$21.14	$20.97	$21.87
Baltimore, Md	22.74	24.95	24.95	22.74	22.74
Baton Rouge, La	16.96	20.44	19.63	19.11	20.98
Billings, Mont	18.77	20.44	16.98	16.98	16.98
Bismarck, N. Dak	17.13	20.44	17.18	17.18	16.05
Casper, Wyo	17.18	19.72	16.77	14.96	18.77
Chicago, Ill	18.86	21.70	19.51	18.86	18.86
Columbia, S.C	20.51	22.41	21.14	21.62	22.76
Columbus, Ohio	20.79	22.73	21.43	20.79	20.79
Concord, N.H	23.38	25.60	25.60	23.38	23.38
Denver, Colo	17.18	19.72	17.18	9.21	19.62
Des Moines, Iowa	16.71	19.76	16.71	16.71	16.71
Harrisburg, Pa	22.74	24.95	24.95	22.74	22.74
Indianapolis, Ind	20.54	22.47	21.18	20.54	20.54
Jackson, Miss	17.30	19.62	18.99	18.75	20.09
Jacksonville, Fla	20.30	22.15	21.52	21.37	22.76
Lansing, Mich	20.79	22.73	21.43	20.79	20.79
Lexington, Ky	20.79	21.78	21.49	20.79	20.98
Little Rock, Ark	17.11	20.44	19.63	19.11	20.98
Madison, Wis	17.31	20.60	17.31	17.31	17.31
Montgomery, Ala	18.74	20.65	20.00	19.81	20.98
Nashville, Tenn	19.25	21.15	20.51	20.40	20.38
North Platte, Nebr	17.18	19.72	17.18	17.18	17.31
Oklahoma City, Okla	11.74	17.39	19.63	19.11	20.98
Pierre, S. Dak	17.18	20.44	17.18	17.18	16.87
Pocatello, Idaho	23.41	20.38	11.20	17.29	23.36
Portland, Oreg	21.57	18.35	18.35	18.35	21.57
Raleigh, N.C	21.78	23.68	23.04	22.92	22.76
Richmond, Va	22.74	24.10	24.95	22.74	22.74
Seattle, Wash	22.28	19.08	19.08	19.08	22.38
St. Louis, Mo	17.18	20.44	17.18	17.18	17.31
St. Paul, Minn	17.18	20.44	17.31	17.18	16.28
Syracuse, N.Y	22.74	24.95	24.95	22.74	22.74
Texarkana, Tex	13.65	17.39	19.63	19.11	21.57
Wichita, Kans	16.71	19.72	16.71	16.71	19.62

by truck to Northgate, for about \$4.75 per ton.

From Northgate, the KCl is transported by unit trainloads weighing at least 10,000 tons to Minneapolis and St. Paul, Minn., and Allovez, Wis., at \$4.23 per ton; to Albert Lea, Minn., and Manly, Iowa, at \$4.74 per ton; to Mendota and Beardstown, Ill., at \$6.01 per ton; to Menon and Sheridan, Ind., at \$6.83 per ton; and to Bellefontaine and Columbus, Ohio, at \$7.77 per ton.[2] These low rates are obtainable only when the total tonnage from all shippers amounts to 200,000 tons during January to June, or 220,000 tons during July to December.

PRICES

Standard domestic potassium muriate (KCl), f.o.b. refineries, had an average sales value of \$20.22 per ton in 1972 compared with \$19.27 per ton of KCl in 1971. The average sales value of coarse KCl was \$21.58 per ton compared with \$21.50 per ton in 1971. The average sales value of granular KCl was \$22.09 per ton in 1972 compared with \$22.84 per ton in 1971.

The average sales value of domestic potassium sulfate at refineries was \$41.76 per ton compared with \$36.43 per ton in 1971.

The average value of U.S. imports for consumption of all types of potassium muriate from Canada was \$22.97 per ton of KCl at Canadian points of exportation compared with \$23.18 per ton in 1971.

Higher prices since 1970 have been largely attributed to existence of the Province of Saskatchewan's Potash Conservation Regulations.

Quoted prices on various New Mexico and Saskatchewan potash materials are shown in table 7.

In Phase II of the President's economic stabilization controls, effective November 1971, the Price Commission permitted potash producers to continue using seasonal fluctuations of prices for their products.

Table 7.—Bulk prices for potash in 1972[1]

(U.S. cents per unit K_2O)

	Jan. 1	Feb. 1	May 15	July–Aug.	Sept.–Dec.
Muriate, 60% K_2O minimum:					
Carlsbad, N. Mex. and Saskatchewan: [2]					
Standard	33.75	35	33.75	33.75	33.75
Soluble 62% to 63% K_2O	36	38	35	--	36
Coarse	39	42	37	--	39
Granular	40	43	38	--	40
Sulfate of potash, 50% K_2O minimum:					
Carlsbad, N. Mex.:					
Regular	80	--	--	--	80
Granular	90	--	--	--	90
Mine-run salts, minimum 20% K_2O, Carlsbad, N. Mex.	17.65	--	--	--	17.65

[1] Carlots, f.o.b. cars.
[2] Saskatchewan shipments to U.S. destinations.

Source: Potash Co. of America, Division of Ideal Basic Industries, Inc.

FOREIGN TRADE

Exports and imports of potash fertilizer and chemical materials are shown in tables 8–9.

Exports of 1.35 million tons of potassium salts (764,000 tons of K_2O) were unusually large. Of these salts, 1.13 million tons were potassium chloride.

Imports for consumption of potash materials are shown in tables 10–11. Imports for consumption of 4.97 million tons of potassium salts (2.96 million tons of K_2O) broke all records and were larger than domestic production for the second consecutive year. A total of 4.64 million tons of potassium chloride (about 2.8 million tons of K_2O) valued at \$106.5 million was imported from Canada in 1972 compared with 4.4 million tons of potassium chloride (2.7 million tons of K_2O) valued at \$102.9 million in 1971.

[2] Burlington Northern, Inc.. Freight Tariff 13-C. Oct 6, 1972, 12 pp.

Table 8.—U.S. exports of potash materials, by use

Materials	Approximate equivalent as potash (K_2O) %	1971 Short tons	1971 Approximate equivalent as potash (K_2O) Short tons	1971 Approximate equivalent as potash (K_2O) % of total	1971 Value (thousands)	1972 Short tons	1972 Approximate equivalent as potash (K_2O) Short tons	1972 Approximate equivalent as potash (K_2O) % of total	1972 Value (thousands)
Used chiefly as fertilizers:									
Potassium chloride, all grades	60	754,561	452,737	r 78.5	$23,766	1,133,977	680,386	87.5	$36,109
Potassic chemical fertilizer, n.e.c	40	276,035	110,414	r 19.1	11,458	200,764	80,306	10.3	9,223
Natural potassic salt fertilizers, crude	20	2,352	470	.1	99	18,730	3,746	.5	526
Total	--	1,032,948	563,621	r 97.7	35,323	1,353,471	764,438	98.3	45,858
Used chiefly in chemical industries:									
Potassium hydroxide	80	r 5,874	r 4,699	r .8	r 722	7,033	5,626	.7	990
Potassium peroxide	83	13	11	--	13	14	12	--	7
Potassium compounds, n.e.c	31	27,290	8,460	r 1.5	6,030	24,388	7,560	1.0	5,893
Total	--	r 33,177	r 13,170	r 2.3	r 6,765	31,435	13,198	1.7	6,890
Grand total	--	r 1,066,125	r 576,791	100.0	r 42,088	1,384,906	777,636	100.0	52,748

r Revised.

Table 9.—U.S. exports of potash materials, by country

Destination	Fertilizer: Chloride quantity (short tons) 1971	Fertilizer: Chloride quantity (short tons) 1972	Fertilizer: Chemical fertilizer n.e.c. quantity (short tons) 1971	Fertilizer: Chemical fertilizer n.e.c. quantity (short tons) 1972	Fertilizer: Total 1971 Quantity (short tons)	Fertilizer: Total 1971 Value (thousands)	Fertilizer: Total 1972 Quantity (short tons)	Fertilizer: Total 1972 Value (thousands)	Chemical: Hydroxide (caustic) quantity (short tons) 1971	Chemical: Hydroxide (caustic) quantity (short tons) 1972	Chemical: Other n.e.c. quantity (short tons) 1971	Chemical: Other n.e.c. quantity (short tons) 1972	Chemical: Total 1971 Quantity (short tons)	Chemical: Total 1971 Value (thousands)	Chemical: Total 1972 Quantity (short tons)	Chemical: Total 1972 Value (thousands)
Algeria	30,829	7,979	11,200	--	[1]42,140	[1]$2,231	7,979	$425	--	--	--	18	--	--	18	$8
Argentina	4,667	6,876	3,146	6,067	[1]9,599	[1]313	12,943	426	32	--	307	270	339	$95	270	92
Australia	66,866	76,912	12,294	7,449	79,160	2,252	[1]89,860	[1]2,637	80	59	367	476	447	114	535	191
Belgium-Luxembourg	--	--	--	440	--	--	440	16	--	24	78	45	78	61	69	33
Brazil	208,556	394,159	2,425	4,187	210,981	6,887	[1]403,306	[1]13,092	624	537	1,603	880	2,227	459	1,417	419
Canada	59,559	59,320	40,245	54,576	[1]100,069	[1]3,716	[1]114,063	[1]4,191	3,489	4,330	6,413	6,166	[2]9,915	[2]1,695	10,496	2,353
Chile	17,212	20,156	1,652	--	18,864	577	20,156	599	--	--	287	51	287	80	51	13
Colombia	21,536	31,079	5,384	7,060	26,920	836	[1]39,517	[1]1,346	68	112	185	6,917	253	58	7,029	278
Costa Rica	38,765	51,970	6,194	2,810	44,959	1,505	54,780	1,798	--	4	27	47	27	5	51	11
Dominican Republic	8,307	11,896	302	366	8,609	289	12,262	420	--	9	8	950	8	4	959	88
France	--	23,821	--	--	--	--	23,821	843	--	--	119	4	119	43	4	1
Germany, West	--	--	--	--	--	--	--	--	--	--	2,956	2,392	2,956	1,155	[2]2,394	[2]1,051
Guatemala	--	2,753	60	125	60	2	2,878	84	3	34	97	36	100	29	70	22
Honduras	1,785	159	277	10	2,062	113	169	7	6	--	583	452	589	39	452	23
India	--	--	--	--	--	--	--	--	--	--	155	114	155	67	114	35
Italy	--	--	26,896	--	26,896	1,078	--	--	--	--	50	12	50	10	[2]24	[2]13
Japan	107,079	115,901	109,313	50,844	216,392	7,632	[1]170,053	[1]6,365	--	--	140	267	140	65	267	99
Mexico	57,010	74,898	20,717	23,814	77,727	2,453	98,712	3,105	546	1,018	2,234	1,614	2,780	641	2,632	579
Netherlands	--	--	--	--	--	--	--	--	22	33	345	101	367	249	134	62
New Zealand	52,147	101,783	452	--	52,599	1,431	101,783	3,021	--	--	62	76	62	26	76	30
Pakistan	--	--	--	--	--	--	--	--	60	--	428	388	488	104	388	94
Philippines	67	23,844	15	142	82	3	[1]27,333	[1]822	12	34	63	77	75	41	111	50
Singapore	5,600	6,076	3,360	10,839	8,960	331	16,915	747	--	--	--	12	--	--	12	21
South Africa, Republic of	52	42	--	--	52	2	42	1	23	74	14	75	37	17	149	48
Sweden	8,066	18,990	4,684	--	12,750	413	18,990	529	--	--	65	9	65	19	9	3
Taiwan	32,012	50,714	5,236	--	[1]37,317	[1]1,136	50,714	1,572	--	3	129	274	129	63	277	64
U.S.S.R.	--	--	--	--	--	--	--	--	(3)	--	1,103	1,103	[r]1,103	[r]563	1,103	526
United Kingdom	40	--	--	--	40	1	--	--	--	--	978	667	978	215	667	184
Venezuela	166	4,383	9,800	--	9,966	418	4,383	134	240	176	5,512	347	5,752	367	523	144
Vietnam, South	--	8,370	2,866	4,577	2,866	179	12,947	739	110	--	2,442	150	2,552	204	150	46
Other	34,240	41,896	9,517	27,458	[1]43,878	[1]1,525	[1]69,425	[1]2,939	559	586	540	398	[2]1,099	[2]277	984	309
Total	754,561	1,133,977	276,035	200,764	[1]1,032,948	[1]35,323	[1]1,353,471	[1]45,858	[r]5,874	7,033	27,290	24,388	[r]33,177	[r]6,765	[2]31,435	[2]6,890

[r] Revised.
[1] Includes crude natural potassic salt fertilizer—1971: Canada, 265 tons ($8,880); Taiwan, 69 tons ($2,300); Algeria, 111 tons ($3,730); Argentina, 1,786 tons ($65,553); Guyana, 121 tons ($18,360). 1972: Canada, 167 tons ($5,593); Bahamas, 71 tons ($3,125); Colombia, 1,378 tons ($45,750); Brazil, 4,960 tons ($157,500); Philippines, 3,347 tons ($50,205); Japan, 3,308 ($91,615); Australia, 5,499 tons ($171,864).
[2] Includes potassium peroxide—1971: Canada, 13 tons ($12,950); British Honduras, less than 1 ton ($500). 1972: West Germany, 2 tons ($1,770); Italy, 12 tons ($5,128).
[3] Revised to none.

Table 10.—U.S. imports for consumption of potash materials, by use

Materials	Approximate equivalent as potash (K_2O) %	1971 Short tons	1971 Approximate equivalent as potash (K_2O) Short tons	1971 Approximate equivalent as potash (K_2O) % of total	1971 Value (thousands)	1972 Short tons	1972 Approximate equivalent as potash (K_2O) Short tons	1972 Approximate equivalent as potash (K_2O) % of total	1972 Value (thousands)
Used chiefly as fertilizers:									
Muriate (chloride)	60	4,549,098	2,729,459	98.4	$106,180	4,858,740	2,915,244	98.2	$113,611
Potassium nitrate, crude	40	21,981	8,792	.3	1,421	20,885	8,354	.3	1,673
Potassium sodium nitrate mixtures, crude	14	61,168	8,564	.3	2,651	27,823	3,895	.1	1,447
Potassium sulfate, crude	50	39,185	19,593	.7	1,575	65,615	32,806	1.1	2,798
Other potash fertilizer material	6	760	46	(1)	17	5,587	335	(1)	137
Total	--	4,672,192	2,766,454	99.7	111,844	4,978,650	2,960,634	99.7	119,666
Used chiefly in chemical industries:									
Bicarbonate	46	957	440		247	1,063	489		128
Bitartrate:									
Argols	20	11	2		4	11	2		4
Cream of tartar	25	1,235	309		728	1,173	293		731
Carbonate	61	684	417		88	1,518	926		213
Caustic	80	3,420	2,736		555	1,562	1,250		360
Chlorate and perchlorate	36	623	224	.3	125	432	156	.3	119
Cyanide	70	681	477		301	825	578		364
Ferricyanide	42	866	364		592	1,028	432		728
Ferrocyanide	44	1,039	457		386	999	440		416
Nitrate	50	179	90		23	2,220	1,110		300
Rochelle salts	22	299	66		123	492	108		229
All other	31	5,193	1,610		3,465	6,442	1,997		5,290
Total	--	15,187	7,192	.3	6,637	17,765	7,781	.3	8,882
Grand total	--	4,687,379	2,773,646	100.0	118,481	4,996,415	2,968,415	100.0	128,548

[1] Less than ½ unit.

Table 11.—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)
1971:												
Belgium-Luxembourg	--	168	--	--	--	--	--	--	1,498	933	2,599	$467
Canada	--	7	--	12	4,440,054	170	381	--	48	1,178	4,441,850	103,612
Chile	--	--	--	--	--	5,061	51,774	--	--	17	56,852	2,313
Finland	--	--	--	--	--	--	--	--	--	943	943	116
France	2	346	--	50	--	--	--	--	1,166	745	2,309	354
Germany, West	--	1,382	--	269	16	20	--	40	34,745	2,759	39,231	2,940
Israel	--	--	--	--	94,650	14,730	8,813	--	--	5	118,198	4,445
Italy	710	--	--	--	--	--	--	139	1,722	36	2,607	545
Japan	--	1,380	--	182	--	--	--	--	--	1,213	2,775	1,863
Netherlands	--	--	--	20	--	--	--	--	--	1,476	1,496	480
Spain	501	--	193	--	7,903	--	--	--	--	139	8,736	656
Sweden	--	137	306	--	--	--	--	--	--	10	453	119
United Kingdom	--	--	--	148	--	--	--	(1)	--	285	433	211
Other	22	--	124	--	6,475	2,000	200	(1)	6	70	8,897	360
Total	1,235	3,420	623	681	4,549,098	21,981	61,168	179	39,185	9,809	4,687,379	118,481
1972:												
Belgium-Luxembourg	--	--	--	--	14	--	--	--	80	428	522	284
Canada	--	--	--	6	4,635,679	57	168	--	60	6,019	4,641,989	107,330
Chile	--	--	--	--	6,983	3,525	10,913	--	--	--	21,421	927
Congo (Brazzaville)	--	--	--	--	33,856	--	--	--	--	--	33,856	1,047
Finland	--	--	--	--	--	--	--	--	--	904	904	104
France	6	63	--	--	--	90	--	--	23,211	1,340	24,710	1,302
Germany, West	--	360	--	443	52	--	--	416	42,239	4,190	47,700	4,080
Israel	--	--	--	--	176,280	17,112	10,071	1,563	--	--	205,026	7,979
Italy	752	--	--	--	--	--	--	199	--	92	1,043	571
Japan	--	615	--	161	--	101	--	--	--	1,754	2,631	2,801
Netherlands	--	--	--	--	--	--	--	--	--	1,676	1,676	569
Norway	--	--	--	--	--	--	6,671	--	--	--	6,671	285
Spain	415	--	--	--	--	--	--	--	--	307	722	440
Sweden	--	524	266	--	--	--	--	--	--	(1)	790	251
United Kingdom	--	--	--	215	(1)	--	--	--	--	361	576	307
Zaire	--	--	--	--	5,274	--	--	--	--	--	5,274	151
Other	--	--	166	--	602	--	--	42	25	69	904	120
Total	1,173	1,562	432	825	4,858,740	20,885	27,823	2,220	65,615	17,140	4,996,415	128,548

[1] Less than ½ unit.

Shipments (awards) of various domestic fertilizer materials financed by the Agency for International Development (AID) in 1972 included 5,512 short tons of potassium chloride and potassium sulfate ($328,958) to South Vietnam. In 1971, AID-financed shipments of various domestic fertilizer materials included 4,850 tons of potassium chloride ($240,988), 8,047 tons of potassium sulfate ($528,995), and 772 tons of sulfate of potash magnesia ($33,355) to South Vietnam, 3,858 tons of potassium chloride ($103,600) to Colombia, and 4,985 tons of potassium sulfate ($257,834) to Nigeria and Morocco.

WORLD REVIEW

World production of marketable potash continued at a high level in 1972 as shown in table 12. According to preliminary estimates, the United States was the fourth largest producer. In slightly over a decade, Canada emerged from a nonproducer of potash to the country with the world's largest potash capacity, 8.3 million tons of K_2O annually. The potash operations are all in Saskatchewan. The Province continued to regulate its huge potash industry with production and minimum price controls for the third consecutive year; the facilities operated at about 52% capacity in 1972.

The Saskatchewan Potash Conservation Regulations have been acclaimed by some producers as an outstanding success.[3] A detailed review of the regulations was published.[4]

Table 12.—Marketable potash: World production by country

(Thousand short tons, K_2O equivalent)

Country	1970	1971	1972 p
Canada	3,420	4,000	4,130
Chile	24	34	26
Congo (Brazzaville)	r 138	287	e 310
France	2,099	2,204	e 1,930
Germany, East	2,666	2,674	e 2,680
Germany, West	2,916	3,213	3,136
Israel	611	e r 617	618
Italy	251	236	238
Spain	r 654	666	678
U.S.S.R.	4,505	5,299	e 6,060
United States	2,729	2,587	2,659
Total	r 20,013	21,817	22,465

e Estimate. p Preliminary. r Revised.

Australia.—Texada Mines Pty., Ltd., reportedly began construction of an 88,000 short-ton potash plant costing $4.5 million at Lake McLeod, north of Carnarvon, Western Australia. The plant will produce potash from brine and is expected to come onstream in May 1973. The facility can be easily enlarged to produce 154,000 short tons of potash annually and, if the demand is brisk, expanded to produce 309,000 short tons annually.[5]

Canada.—Cominco, Ltd., resumed sylvinite mining operations at Vade, Saskatchewan, in September after being shut down since August 1970 as the result of a mine flood.[6]

Saskatchewan potash producers organized Canpotex, Ltd., to develop larger offshore markets for their potassium chlorides.

American Metal Climax, Inc., made an agreement in 1971 with IMC (Canada) to purchase some of IMC's potash reserves in Saskatchewan for producing potassium muriate through IMC's facilities.

Potash Co. of America, Division of Ideal Basic Industries, Inc., signed an agreement with the Province of New Brunswick giving the company the sole right to explore the new potash deposits in the Sussex area. The deposits are near the deepwater port

[3] International Minerals & Chemical Corp. Canadian Potash Industry: A Study in Government Cooperation. April 1972, 24 pp.
[4] Karvonen, D. A. The Saskatchewan Potash Prorationing and Price Stabilization Program. Can. Min. and Met. J., v. 66, No. 732, April 1973, pp. 69–74.
[5] Chemical Marketing Reporter. Potash Plant Down Under is Based on a New Process. V. 202, No. 23, Dec. 4, 1972, p. 29.
[6] Northern Miner (Toronto). Cominco Potash Plant Resumes Production. V. 58, No. 41, Dec. 28, 1972, pp. 1, 6.

of Saint John. The agreement also gave the company first option to develop the deposits commercially.[7]

China, Peoples Republic of.—Potassium chloride and various other byproducts are produced during the treatment of lake salt in Tsinghai.

Israel.—A new potassium nitrate plant with a capacity of 120,000 short tons per year reportedly operated at full capacity. Potassium chloride originating in Israel is reacted with nitric acid in aqueous isoamyl alcohol yielding potassium nitrate. The nitrate is removed and further treated for marketing.[8]

U.S.S.R.—The Soviet Union has eight potash facilities consisting of mines and refineries. Of these, three in the Urals and three in Belorussia produce potassium chloride, and two in the Ukraine produce potassium-magnesium sulfate and potassium sulfate.

Room-and-pillar methods of mining are used, and trends are for larger recoveries and greater mechanization. Approximately 120 mechanical miners were used in 1970 to produce about 13 million short tons of ore.

Beneficiation methods in use are about the same as those used elsewhere in the world. However, most of the ores contain several potash minerals and often large amounts of clay. Research on the ores include developing methods for the removal of clay and developing electrostatic beneficiation methods for the direct production of potash products and also for improving ores for flotation.[9]

TECHNOLOGY

Sylvite of Canada's new potash mine near Rocanville, Saskatchewan, is one of the most highly mechanized and automated mining operations in the world. On a 10-hour shift, a supervisor and seven-man crew of operators can produce over 600 tons of sylvite ore per hour. Two four-rotor, 258-ton Marietta mining machines are used for extracting the ore. General plans are for 35% extraction of a 4,000 feet square panel using room-and-pillar methods of mining with rooms parallel and 67 feet wide. The ore deposit is about 3,000 feet below surface and has been described as a gently undulating flat blanket of ore 8 feet thick extending many miles in all directions. The compressive and tensile strengths of the ore are roughly 3,000 pounds per square inch and 500 pounds per square inch, respectively. The hoisting of ore to surface is highly automated; electric power peaks are controlled by varying skip loads of 24 and 15 tons and speeds of 1,000 or 1,800 feet per minute. The operation of all mining equipment and facilities from the working face to storage bins in the headframe on surface is monitored and controled from a single central control panel in the mine.[10]

The highly mechanized potash mining operations of Alwinsal Potash of Canada, Ltd., 8 miles west of Lanigan, Saskatchewan, were described.[11] The Dreyer Formula was used in calculating room-and-pillar dimensions. Rooms are 28 feet wide, pillars 59 feet wide and 146 feet long; panel extraction is 38.5%. With more experience, plans might be changed. Additional crosscutting may be done leaving 59-foot-square pillars. If this is done, ore extraction would be 47%, and the pillar safety factor would be 3. The average grade of mined ore is 25% K_2O, and the company's reserves are estimated at over 100 million tons of K_2O. Skip loads of ore weighing 22.5 tons are hoisted from a depth of 3,250 feet to surface at a speed of 3,600 feet per minute.

Ten years of scientific studies in Saskatchewan's deep potash mines revealed that all mine roof failures follow two basic patterns: mass failure—caused by the weight of overburden, and slab buckling—caused by weak discontinuity planes in the ground. An effective stress control method was developed for stabilizing underground openings based on accurate in situ stress analysis. The success of the new method is

[7] Ideal Basic Industries, Inc. Annual Report 1972. 21 pp.

[8] Industrial Minerals. Company News and Mineral Notes. No. 60, September 1972, p. 49.

[9] Phosphorus and Potassium. Technical Advances by the U.S.S.R. Potash Industry. No. 59, May–June 1972, pp. 41–45.

[10] Schultz, W. G. Sylvite of Canada: The World's Most Modern Underground Potash Mine. Min. Eng., v. 24, No. 7, July 1972, pp. 72–78.

[11] Canadian Mining and Metallurgical Bulletin. The Alwinsal Story. V. 65, No. 726, October 1972, pp. 90–103.

largely due to the development of the Rheological Element Computer Control Method and use of a portable in situ stress meter. Some advantages of using the stress control method are as follows: the development of wider rooms such as those Sylvite of Canada plans to use, complete or partial elimination of roof bolting, increased production efficiency, and better control of ventilation and subsidence.[12]

The Bureau of Mines continued research on developing new and improved beneficiation methods for recovering potash minerals economically from New Mexico low-grade and high-clay slime ores. A mobile beneficiation plant was used for onsite testing of the ores.

---

[12] Serata, S., and W. G. Schultz. Application of Stress Control in Deep Potash Mines. Min. Cong. J., v. 58, No. 11, November 1972, pp. 36–42.

Pumice and Volcanic Cinder

By Arthur C. Meisinger [1]

The quantity of pumice, pumicite, and volcanic cinder sold or used by producers and the quantity of pumice imported for consumption to meet the increased demand for pumiceous materials in construction—related uses set record highs in 1972. Domestic production was 3.8 million tons valued at $6.5 million from 220 operations in 16 States. Pumice imports in 1972 totaled nearly 600,000 tons valued at a record $1.5 million.

DOMESTIC PRODUCTION

Domestic production of pumiceous materials in 1972 was 12% higher in quantity and 25% higher in value than in 1971. The quantity produced in 1972 was 3.8 million tons, a record total. The previous high was established in 1969 when production of pumice, pumicite, and volcanic cinder amounted to 3.6 million tons. The value of 1972 output was $6.54 million, which was the highest since 1966. Volcanic cinder, ash, and scoria comprised 79% of the U.S. output of pumiceous materials and was valued at a record $4.66 million.

Domestic output in 1972 came from 101 firms, individuals, and governmental agencies producing from 220 operations in 16 States. The principal producing States, in order of output, were Oregon, Arizona, and California, and their combined output accounted for two-thirds of the national total. Other States with significant output were Hawaii, Nevada, and New Mexico. Of the six leading States, only Arizona and Oregon showed a decrease in production from that of 1971. California led all producing States with 95 active operations, followed by Arizona with 34, and Hawaii with 22. Volcanic cinder was produced in 13 of the 16 States and in American Samoa from a mine operated by the Samoan Government.

[1] Industry economist, Division of Nonmetallic Minerals.

Table 1.—Pumice, pumicite, and volcanic cinder sold or used by producers in the United States [1]

(Thousand short tons and thousand dollars)

Year	Pumice and pumicite		Volcanic cinder		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1968	481	1,360	3,049	4,210	3,530	5,570
1969	598	1,349	3,011	3,701	3,609	5,050
1970	490	1,233	2,546	3,438	3,036	4,671
1971	540	1,396	r 2,851	r 3,818	r 3,391	r 5,214
1972	790	1,878	3,023	4,661	3,813	6,539

r Revised.
[1] Values f.o.b. mine, (1968–71); value f.o.b. mine or mill, 1972.

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	1971 Quantity	1971 Value	1972 Quantity	1972 Value
Arizona	949	625	915	722
California	699	1,179	731	1,507
Colorado	62	W	59	W
Hawaii	289	779	379	762
Nevada	112	232	W	W
New Mexico	287	601	311	809
Oregon	r 943	r 1,389	923	1,512
Texas	4	4	W	W
Utah	6	10	14	26
Other States [1]	40	395	482	1,199
Total [2]	r 3,391	r 5,214	3,813	6,539
American Samoa	10	35	6	27

r Revised. W Withheld to avoid disclosing individual company confidential data; included with "Other States."

[1] Colorado (value), Idaho, Kansas, Nebraska, Nevada (1972), North Dakota (1972), Oklahoma, Texas (1972), Washington, and Wyoming (1972).

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

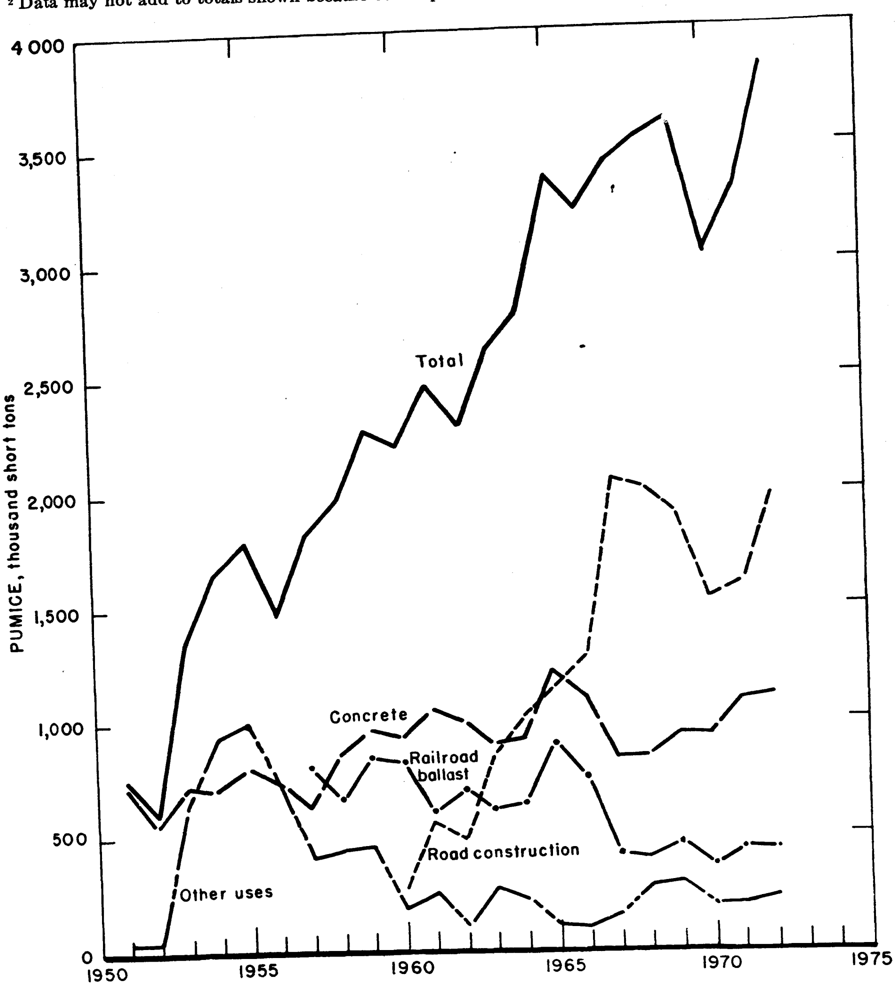

Figure 1.—Pumice and volcanic cinder sold or used by producers in the United States, by use.

CONSUMPTION AND USES

Road construction (including ice control and maintenance) and concrete admixture and aggregate, the principal end uses of pumiceous materials, accounted for 52% and 31%, respectively, of U.S. consumption of pumice and volcanic cinder in 1972. Of the remaining 17%, railroad ballast made up 11% and abrasive materials and other uses, 6%. Landscaping and roofing, combined, accounted for three-fourths of the 212,000 tons of pumice and volcanic cinder included under "other uses" in table 3.

Compared with consumption in 1971, use in road construction increased 18%; use in concrete admixture and aggregate, 11%; and other uses, 9%. On the other hand, use as abrasive materials in cleaning and scouring compounds decreased 25% compared with that of 1971, but use in railroad ballast declined only 1%.

Table 3.—Pumice, pumicite, and volcanic cinder sold or used by producers in the United States, by use

(Thousand short tons and thousand dollars)

Use	1971 Quantity	1971 Value	1972 Quantity	1972 Value
Abrasive-cleaning and scouring compounds	28	79	21	207
Concrete admixture and concrete aggregate	1,077	2,137	1,197	2,406
Railroad ballast	426	280	421	391
Road construction (includes ice control and maintenance)	r 1,664	r 1,905	1,963	2,310
Other uses [1]	195	813	212	1,225
Total [2]	r 3,391	r 5,214	3,813	6,539

r Revised.

[1] Includes miscellaneous abrasive uses, absorbents, heat-or-cold-insulating medium, landscaping, roofing, and miscellaneous uses.

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

PRICES

The average value for crude pumice, pumicite, and volcanic cinder sold and used decreased from $1.07 per ton in 1971 to $0.98 per ton in 1972. Prepared pumice, pumicite, and volcanic cinder, however, increased in average value from $2.20 per ton in 1971 to $2.42 per ton. The weighted average value of pumice, pumicite, and volcanic cinder sold and used was $1.71 per ton compared with $1.54 per ton the previous year. The weighted average value increase of $0.17 was due in large part to rising milling costs and greater demand for prepared material.

The average 1972 price per ton for pumice and volcanic cinder (scoria) used in cleaning and scouring compounds was $9.86, an increase of $7.04 from the 1971 price; for concrete admixture and aggregate, $2.01, a $0.03 increase; for railroad ballast, $0.93, a $0.27 increase; for road construction, $1.18, a $0.04 increase; and for other uses, including landscaping and roofing, $5.78, a $1.61 increase.

Price quotations for pumice in Chemical Marketing Reporter (formerly Oil, Paint, and Drug Reporter) remained unchanged from 1971 and were as follows per pound, bagged, in ton lots: Domestic, fine, $0.0460 to $0.0487; domestic, medium, $0.0510; domestic, coarse, $0.0460; imported (Italian), silk-screened, coarse, $0.06 to $0.076; imported, fine, $0.05; and imported (Italian), sun-dried, fine and coarse, $91 per ton.

Prices quoted at yearend in the American Paint Journal also remained unchanged from 1971, and were as follows for pumice stone per pound, in barrels, f.o.b. New York or Chicago: Powdered $0.0445 to $0.08, and lump $0.0665 to $0.09.

FOREIGN TRADE

The quantity of pumice exported in 1972 was 28% lower than in 1971, and the value was also lower by 33%. Of the 256 short tons exported to 12 countries, Canada received 65% of the exports.

Pumice imported for consumption set a record in 1972, in both quantity and value. Nearly 600,000 short tons was imported, of which 98% was obtained from Greece and Italy, to meet the growing demand for pumice used in the manufacture of concrete masonry products. Total value of all import classes of pumice was $1.5 million compared with $1.1 million in 1971. Imported pumice used in the manufacture of concrete masonry products increased 51% from 388,312 tons in 1971 to 587,269 tons, and imports classed as crude or unmanufactured increased 3% from 8,833 tons to 9,094 tons in 1972. Imports classed as wholly or partly manufactured, however, decreased 4% from 2,588 tons in 1971 to 2,489 tons.

Pumice stone, TSUS No. 519.05, for use in concrete products continued to be admitted into the United States duty free. Duties for other pumice products were as follows: TSUS No. 519.11, crude or crushed pumice, valued not over $15 per ton, 0.02 cent per pound; TSUS No. 519.14, crude or crushed pumice, valued over $15 per ton, 0.04 cent per pound; TSUS No. 519.31, grains or ground, pulverized or refined, 0.17 cent per pound; and TSUS Nos. 519.93 and 523.61, millstones, abrasive wheels, and abrasive articles n.s.p.f. and articles, n.s.p.f., 7% ad valorem.

Table 4.—U.S. exports of pumice

Year	Short tons	Value (thousands)
1969	533	$77
1970	304	70
1971	357	51
1972	256	34

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.
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Value (thousands)
1971:							
Greece	22	(1)	--	--	241,639	$455	--
Italy	8,811	$109	2,588	$143	144,961	372	$14
Leeward and Windward Islands	--	--	--	--	1,712	5	--
Other [2]	--	--	--	--	--	--	4
Total	8,833	109	2,588	143	388,312	832	18
1972:							
Greece	--	--	--	--	257,759	544	--
Italy	9,094	149	2,489	149	329,510	657	19
Mexico	--	--	(1)	1	--	--	--
Other [3]	--	--	--	--	--	--	5
Total	9,094	149	2,489	150	587,269	1,201	24

[1] Less than ½ unit.
[2] Canada, Hong Kong, Belgium-Luxembourg, United Kingdom.
[3] Canada, Hong Kong, Estonia, West Germany, Japan.

Table 6.—Pumice and related volcanic materials: World production by country
(Thousand short tons)

Country [1]	1970	1971	1972 p
Argentina [2]	36	21	e 20
Austria: Pozzolan	22	36	e 40
Cape Verde Islands: Pozzolan	r 19	10	e 11
Chile: Pozzolan	179	161	175
Dominica	68	e 70	e 70
Egypt, Arab Republic of	(3)	(3)	(3)
France:			
Pumice	1	e 1	e 1
Pozzolan and lapilli	737	772	691
Germany, West (marketable)	r 4,645	5,534	e 5,400
Greece:			
Pumice	497	462	e 460
Pozzolan	645	675	e 680
Guadeloupe: Tuff (pozzolanic)e	50	50	50
Guatemala: Volcanic ash (for cement)e	50	50	60
Iceland	12	26	[4] 19

Table 6.—Pumice and related volcanic materials: World production by country—Continued

(Thousand short tons)

Country [1]	1970	1971	1972 [p]
Italy:			
Pumice and pumiceous lapilli	[r] 849	1,242	[e] 1,250
Pozzolan	4,693	[e] 4,700	[e] 4,700
Martinique: Pumice [e]	20	20	20
New Zealand	21	14	14
Spain [5]	220	172	[e] 180
United States (sold or used by producers):			
Pumice and pumicite	490	540	790
Volcanic cinder [6]	2,548	2,861	3,029
Total	[r] 15,802	17,417	17,660

[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. Japan's last available output figure 110,000 tons in 1958.

[2] Unspecified volcanic materials produced mainly for use in construction products.

[3] Less than ½ unit.

[4] Exports.

[5] Includes Canary Islands.

[6] Includes American Samoa.

Rare-Earth Minerals and Metals

By James S. Kennedy [1] and James H. Jolly [2]

The rare-earth industry in 1972 was highlighted by planned expansion of production facilities, increased demand for rare-earth products, changes in demand patterns, and promising technological developments.

The Molybdenum Corp. of America (Molycorp) announced plans to expand its bastnaesite mill at Mountain Pass, Calif. Titanium Enterprise's facilities for production of byproduct monazite near Green Cove Springs, Fla., were completed and went on stream late in the year. Shipments from rare-earth chemical processors increased and, for the first time in the history of the industry, metallurgical consumption surpassed that of the petroleum industry as the largest market for rare-earth products. The growing metallurgical demand for mischmetal prompted the Aluminum Co. of America (Alcoa) to enter the industry in a joint venture with Molycorp.

Worldwide, Australia, India, Brazil, and Malaysia remained the leading producers of monazite concentrates. Export destinations of the Australian material changed markedly during the year. Production of rare-earth compounds and metals appeared adequate to meet market demand although mischmetal was reported in short supply in the United Kingdom. Mischmetal producers in Western Europe were reportedly prepared to expand capacity, estimated at 1,500 tons per year, in order to meet growing market requirements.

Legislation and Government Programs.—At the end of 1972, the General Services Administration (GSA) held a total of 11,817 short tons (dry) of rare earth oxide (REO) equivalent in the national (9,714 tons) and supplemental (2,103 tons) stockpiles, compared with 11,841 tons at the end of 1971. Although 1,250 tons of REO content was authorized for disposal in 1972, less than 27 tons of REO contained in bastnaesite was sold during the year. In addition several test samples of rare-earth chloride from the stockpile were provided to industry.

DOMESTIC PRODUCTION

Concentrate.—The Mountain Pass, Calif., operation of Molycorp produced 11,802 tons of REO in flotation concentrate from 228,488 tons of bastnaesite ore mined and milled. Production was sluggish at the beginning of the year but was near capacity during the fourth quarter. In anticipation of increased demand, a $850,000 expansion program was announced in January 1973, to increase mill and flotation capacity by 50% to 30,000 tons REO annually. The new facilities are expected to be on stream in August 1973.[3]

Molycorp acquired options on several tracts of land in Johnson and Pawnee Counties in southeastern Nebraska, where test drilling in the Elk Creek carbonatite showed the presence of rare-earth minerals, among others. Analysis of the test hole drilled in 1971 by a survey team from the University of Nebraska, with support from the Bureau of Mines, revealed the presence of up to 1.1% cerium, 0.34% lanthanum, and traces of europium.[4]

Humphreys Mining Co. continued recovery of byproduct monazite from a beach sand deposit controlled by E. I. du Pont de Nemours & Co., near Folkston, Georgia.

[1] Industry economist, formerly with the Division of Nonferrous Metals.
[2] Physical scientist, Division of Nonferrous Metals.
[3] Molybdenum Corporation of America. 1972 Annual Report. Mar. 12, 1973, 12 pp.
[4] Treves, Samuel B., Russell Smith, Marvin P. Carlson, and George Cohen. The Elk Creek Carbonatite, Johnson and Pawnee Counties, Nebraska. Abs. with Programs, Geol. Soc. Amer., v. 4, No. 4, February 1972, p. 297.

Production declined slightly from that of 1971. As a result of its land reclamation program, Humphreys Mining Co. was presented the State of Georgia's first honor award for outstanding reclamation achievement.[5]

Titanium Enterprises, owned jointly by American Cyanamid Co. and Union Camp Corp., became a second producer of domestic monazite late in the year. The monazite produced is a byproduct in mining beach sand for titanium and zirconium minerals near Green Cove Springs, Fla.

Compounds and Metals.—Production of rare-earth compounds at the Louviers, Colo., Washington, Pa., and York, Pa., plants of Molycorp increased 24% in terms of contained REO; the value of production increased proportionally. The solvent extraction unit at Louviers includes facilities for production of selected high-purity oxides, including yttrium and europium.

Other major rare-earth chemical processors included Lindsay Rare Earths Division of Kerr-McGee Chemical Corp., West Chicago, Ill., and W. R. Grace & Co., Davison Chemical Div., Chattanooga, Tenn.

Smaller producers of rare-earth com-

[5] Engineering and Mining Journal. V. 173, No. 9, September 1972, p. 197.

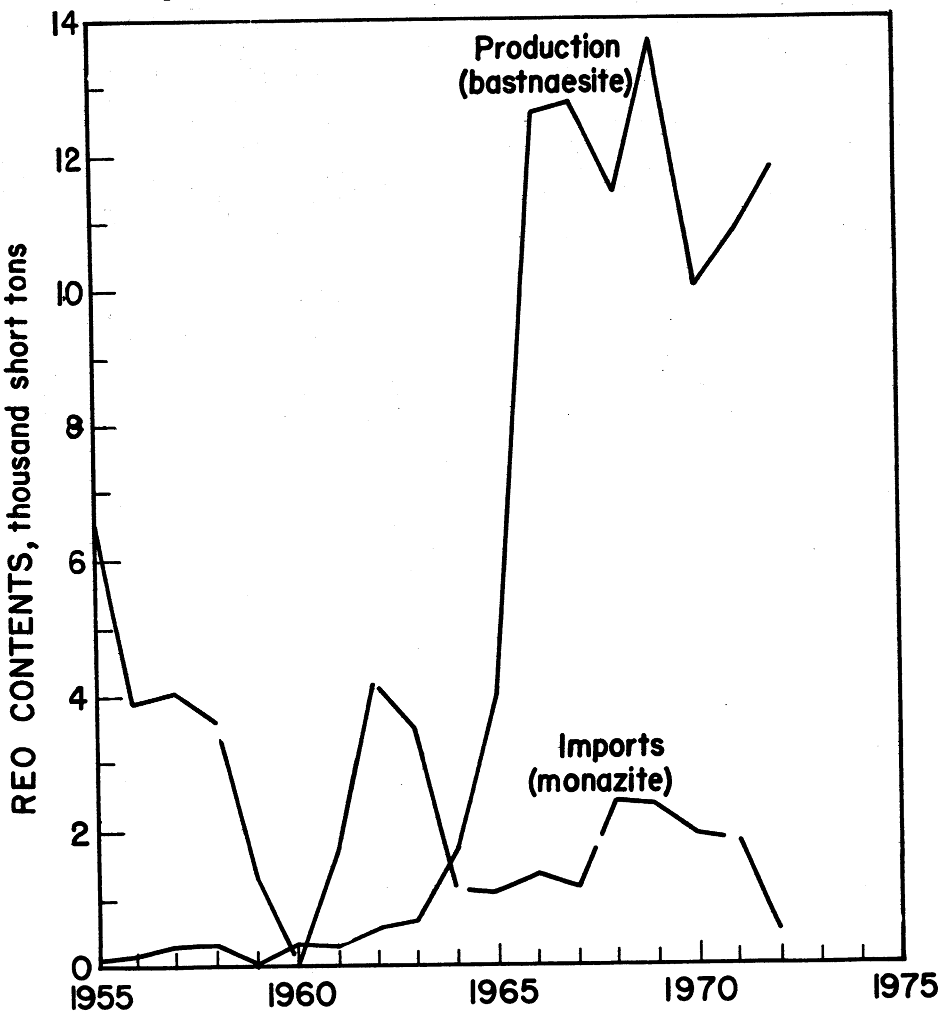

Figure 1.—Domestic production of bastnaesite and imports of monazite.

pounds and metals were: Atomergic Chemetals Co., Div. of Gallard-Schlesinger Chemical Manufacturing Corp., Carle Place, N.Y.; Michigan Chemical Corp., St. Louis, Mich.; Research Chemicals Div., Nucor Corp. (formerly Nuclear Corp. of America), Phoenix, Ariz.; and Transelco, Inc., Penn Yan, N.Y. Molycorp, W. R. Grace, Kerr-McGee, Michigan Chemical, Gallard-Schlesinger, and Nucor produced yttrium oxide and metal during the year.

Production of mischmetal and other pyrophoric alloys, limited to Ronson Metals Corp. and American Metallurgical Products Co., Inc. (Amet) increased 16% while shipments rose 41% over those of 1971. Reaction Metals Inc., a subsidiary of Rare Earth Industries, Inc., Orlando, Fla., acquired Amet's mischmetal plant at Newcastle, Pa., during the year. Amet will continue as marketing representatives for rare-earth additives produced for the steel industry.[6]

Electralloy Corp., Oil City, Pa., began experimental production of a REO containing deoxidation alloy for use in the steel industry. Full production was planned for 1973.

Formation of Rare Earth Metals Co. of America (Remcoa), a joint venture of Alcoa (51%) and Molycorp (49%), was announced.[7] A pilot plant for evaluation and modification of an electrolytic reduction process developed by the Bureau of Mines Metallurgy Research Center, Reno, Nev.,[8] is to be installed at Molycorp's Washington, Pa., facility. Plans include construction of a plant with an annual capacity of 500,000 pounds, scheduled for completion by 1974. Production will be limited to mischmetal, rare-earth metals, and rare-earth alloys.

CONSUMPTION AND USES

Domestic rare-earth processors consumed an estimated 16,100 tons of REO contained in raw material during 1972. Bastnaesite consumption more than doubled while consumption of monazite declined almost 10%. Consumption of monazite by W. R. Grace at Chattanooga, Tenn., increased more than 28%.

Shipments of rare-earth products from principal processing plants to domestic consumers totaled about 9,400 tons REO, valued at $18 million. This quantity includes intracompany shipments by Molycorp, but does not include products derived from further processing at its plants in Pennsylvania and Colorado. The following estimated quantitative percent distribution of rare-earth products usage during 1972 is based on information supplied by primary processors and on actual data from certain consumers: Metallurgical, including nodular iron and steel, other alloys, and lighter flints, 44%; petroleum cracking catalysts, 33%; ceramics and glass, 17%; arc light carbons, 4%; and miscellaneous, including research and development, 2%.

The manufacture of petroleum cracking catalysts containing rare-earth zeolite as the active compound, continued at previous levels. However, this use declined as a percent of total consumption, being replaced by metallurgical applications as the largest consumer of rare-earth products. The impetus for the growth in metallurgical applications resulted in part from demand for large-diameter pipe to be used for the transportation of petroleum products. Rigid physical properties are required for this pipe to withstand the internal pressure and cold of areas such as the Arctic region. Rare-earth silicides, or mischmetal, added to high-strength low-alloy (HSLA) steels, at a rate of about 3 pounds per ton, to replace other additives such as manganese, form refractory sulfides which do not soften or elongate in applications which require rolling or stretching into shape. In addition to pipe, these steels are being used for the production of stronger auto bumpers. The use of rare-earth products in iron and steel was discussed.[9]

The use of low-cost cerium concentrate in glass decolorizing expanded and was primarily responsible for increased consumption of rare-earth products in ceramics and glass. A decolorization process was described.[10]

[6] Metal Bulletin. No. 5729, Sept. 1, 1972, p. 17.
[7] Metals Week. Alcoa and Molycorp Eyeing Rare-Earth Metals. V. 43, No. 32, Aug. 7, 1972, p. 7.
[8] Shedd, E. S., J. D. Marchant, and M. M. Wong. Electrowinning Misch Metal From a Treated Bastnasite Concentrate. BuMines RI 7398, June 1970, 11 pp.
[9] Cannon, Joseph G. How the Rare-Earth Metals Are Making It in Steel. Amer. Metal Market., v. 79, No. 233, Dec. 20, 1972, pp. 1a & 8a.
[10] Shutt, T. C. and G. Barlow. Practical Aspects of Cerium Decolorization of Glass. Am. Ceram. Soc. Bull., v. 51, No. 2, February 1972, pp. 155–157.

Interest in high energy permanent magnets, containing samarium alloyed with cobalt, continued strong with expanding demand. Varian Associates and Hamilton Precision Metals Co. announced commercial production of samarium-cobalt magnets in 1972. Applications are restricted to those uses that can take full advantage of their high energy density, such as aircraft and spacecraft motors and instruments, hearing aids, electronic tubes, and electric watches.

A new copper-base brazing alloy, containing lanthanum, was introduced during the year.[11] The addition of lanthanum enhances weldability and provides gettering and grain refining action. Available in powder or tape form, the alloy is applicable in joining different base metals from thin foils to thick sections and is suitable for wide gap brazing. Cost savings are possible because the alloy replaces more expensive gold or silver alloys in many applications.

In addition to its well-established use as a host material in color television phosphors, in the form of high-purity oxide, yttrium has various other applications. Cubic crystals of yttrium-aluminum-garnet (YAG) are substituted for diamonds in jewelry due to their high refractory index, hardness, and transparency. Neodymium-doped YAG lasers appear to be gaining wider acceptance in materials processing applications, such as hole drilling, welding, cutting operations, and scribing. Other uses for yttrium include high-temperature alloys and superalloys in such applications as turbine blades and vanes and are being considered for automobile thermal reactors.

STOCKS

Bastnaesite concentrate stocks held by the principal producer and five other chemical processors at yearend declined 10%; monazite concentrate stocks held by two chemical processing companies, however, declined 58%. Stocks of yttrium oxide and europium oxide held by four companies increased slightly. Mischmetal stocks held by two principal producers increased threefold, returning to levels maintained in the late 1960's. High-purity metals held by five firms were 71% lower at yearend than at the first of the year.

PRICES

Prices for domestic monazite remained stable during the year. On the London market the average c.i.f. price per metric ton of Australian monazite with a minimum of 60% REO plus ThO_2, quoted in Metal Bulletin (London) remained at $187 to $206 throughout the year. Malaysian xenotime concentrate with a minimum of 25% yttrium oxide as quoted in Industrial Minerals (London) remained unchanged at $3 to $5 per pound.

Unleached, leached, and calcined bastnaesite containing 55% to 60%, 68% to 72%, and 85% to 90% REO remained at 30, 35, and 40 cents per pound of REO, respectively, f.o.b. Mountain Pass or Nipton, Calif., in 100-pound paper bags or 55-gallon steel drums in truckload or carload lots.

Quoted prices per pound, f.o.b. plant, on certain rare-earth compounds were as follows: mixed rare-earth oxides, 97% REO, $1.40 for 500-pound lots decreasing to $1.10 for lots over 5 tons; chlorides, $0.29; carbonates, $0.83; fluorides, $0.90; and hydrates, $1.30. Quoted prices on cerium hydrate were stable for the year ranging from $1.30 to $1.60 per pound depending on purity and REO content; prices for polish-

Table 1.—Prices of high purity oxides and metals in 1972 [1]

(Dollars per pound)

Element	Oxide [2]	Metal [3]
Cerium	6.00	21.00
Dysprosium	75.00	140.00
Erbium	80.00	310.00
Europium	425.00	3,200.00
Gadolinium	47.00	170.00
Holmium	180.00	285.00
Lanthanum	4.15	35.00
Lutetium	2,300.00	6,500.00
Neodymium	14.00	102.00
Praseodymium	35.00	100.00
Samarium	38.00	125.00
Terbium	450.00	700.00
Thulium	1,350.00	2,750.00
Ytterbium	135.00	285.00
Yttrium	32.00	150.00

[1] Prices from American Metal Market, lower prices are available for some commodities from some producers.
[2] Minimum of 99.9% purity.
[3] Minimum 1 pound.

[11] Metal Bulletin. No. 5765, Jan. 9, 1973, p. 12.

ing grade cerium oxide ranged from $1.20 to $2.00 per pound in 50-pound lots depending on quality and purpose; optical grade cerium oxide remained at $1.85 to $1.90 in lots of 50 pounds or more.

Quoted prices on 1-pound ingots in 50- to 100-pound lots of 97% didymium metal and cerium-free mischmetal remained at $15 and $5, respectively, f.o.b. plant. Mischmetal, 99.8%, was quoted at $3.10 per pound, same basis. Rare-earth silicide, 30% to 35% REO, was quoted at $1.50 to $1.56 per pound contained rare-earth metal, in lots of 15 tons or more.

Cerium metal, 99% pure, delivered in the United Kingdom as quoted in the Mining Journal (London) remained at $16.80 per pound, nominal.

FOREIGN TRADE

According to the sole domestic producer, Molycorp, exports of bastnaesite concentrate remained at the 1971 level of 2,500 tons contained REO. According to Bureau of the Census data, exports of ferrocerium and other pyrophoric alloys to France, Italy, Canada, and 18 other countries increased more than 236% to 202,206 pounds, valued at $609,678. The unit value ranged from $0.26 (Netherlands Antilles) to $7.23 (Australia) and averaged $3.02, compared with $2.72 in 1971. Exports of compounds and mixtures of rare-earth metals, yttrium, and scandium, increased from 763,951 pounds, valued at $1,480,116 in 1971 to 1,514,605 pounds valued at $3,143,895 in 1972, due primarily to the shipment of 799,480 pounds, valued at $191,875, to Austria. The increase in value was due to larger shipments of higher value material to Italy, Canada, and West Germany.

Imports of monazite sand declined substantially from the previous year. Shipments from Malaysia were reduced by 43% and, for the first year since the early 1960's, there were no monazite imports from Australia.

Cerium oxide imports from France and Switzerland totaled 9,219 pounds, valued at $23,342. Imports of cerium chloride increased substantially due to Canadian shipments of 2,556 pounds, valued at $1,534. Austrian shipments declined to 685 pounds, valued at $991. Other cerium imports from five countries, primarily France and the Netherlands, totaled 6,354 pounds, valued at $12,981.

Imports of rare-earth metals increased sharply during the year, although the value of the Japanese material declined considerably. Imports of ferrocerium and other pyrophoric alloys increased to 27,870 pounds valued at $94,347. Japan supplied 23,938 pounds, valued at $77,402, followed by West Germany, the United Kingdom, Austria, Taiwan, and France. The decrease in unit value, from $5.08 to $3.39, was due to the lower value of the Japanese material. Imports of mischmetal from West Germany declined from 52,204 pounds in 1971 to 22,118 pounds in 1972; there were no mischmetal imports from the United Kingdom in 1972.

Under the General Agreement on Tariffs and Trade ("Kennedy round") the tariff on cerium chloride and oxide was reduced on January 1, 1972, to 15% ad valorem. The rate for alloys of rare-earth metals and mischmetal was reduced to 50 cents per pound while the rate for ferrocerium and other pyrophoric alloys was reduced to 50 cents per pound plus 6% ad valorem.

Table 2.—U.S. imports for consumption of monazite, by country

Country	1968		1969		1970		1971		1972	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
Australia	2,810	$369	2,478	$300	1,977	$251	1,802	$219	--	--
Germany, West	24	4	--	--	--	--	--	--	--	--
Hong Kong	--	--	167	20	--	--	--	--	--	--
Malaysia	1,514	188	1,561	174	1,307	157	1,571	165	894	$89
Nigeria	19	2	--	--	--	--	--	--	--	--
Thailand	--	--	--	--	164	19	--	--	--	--
Total	4,367	563	4,206	494	3,448	427	3,373	384	894	89
REO content [e]	2,400	XX	2,310	XX	1,900	XX	1,860	XX	492	XX

[e] Estimate. XX Not applicable.

Table 3.—U.S. imports for consumption of rare-earth metals
(Including scandium and yttrium)

Country	1970		1971		1972	
	Pounds	Value	Pounds	Value	Pounds	Value
Australia	1	$704	--	--	--	--
Germany, West	343	5,150	153	$4,197	--	--
Japan	25	2,005	25	4,169	2,465	$5,585
Norway	--	--	--	--	22	535
U.S.S.R.	89	9,183	395	8,689	2,650	51,870
United Kingdom	16	3,731	15	4,553	23	7,957
Total	474	20,773	588	21,608	5,160	65,947

WORLD REVIEW

Australia.—A pilot plant for evaluating methods of extracting rare-earths as a byproduct of uranium production was constructed at the Mary Kathleen mine, Queensland. Reconditioning of mine and mill facilities, currently on a care and maintenance status, is planned to begin in 1973 with production scheduled for late 1974.[12]

Canada.—Denison Mines, Ltd., announced plans to resume production of yttrium oxide early in 1973, according to the firm's 1972 annual report. Production ceased in mid-1970 after difficulties were encountered in marketing the product.

Finland.—Production of lanthanide concentrate at the Korsnäs lead mine of Outokumpu Oy was discontinued in 1971 due to lack of demand. Typpi Oy, which produced rare-earth compounds from concentrates formerly supplied by Outokumpu Oy, merged into another company, Kemira Oy.

Germany, West.—Goldschmidt A.G. terminated production of all rare-earth products (including europium oxide) except mischmetal and rare-earth metals and alloys for use in rare-earth magnets. Higher prices for rare earths were reported as a result of requirements to reduce air pollution.

India.—According to the annual report of Indian Rare Earths, Ltd. (IRE) for the year ending March 31, 1972, production of monazite increased to 4,664 tons from 4,004 tons in fiscal year 1971. The Alwaye plant, Kerala State, processed 4,165 tons of monazite during the fiscal year and produced 4,920 tons of rare-earth chloride, 55 tons of rare-earth fluoride, and 37 tons of rare-earth oxide.

Sales of rare-earth chloride increased to 4,820 tons valued at $1,128,000. Sales of

[12] Mining Journal. Australian Developments Continue Apace. V. 279, No. 7157, Oct. 20, 1972, p. 313.

Table 4.—Monazite concentrate: World production by country
(Short tons)

Country [1]	1970	1971	1972 p
Australia	r 4,891	4,854	5,537
Brazil	2,544	1,502	2,453
India [2]	4,004	4,664	e 4,700
Malaysia [3]	1,827	1,621	1,927
Mauritania e	110	110	110
Mozambique	2	--	--
Nigeria	14	102	11
Sri Lanka (formerly Ceylon)	18	7	e 10
Thailand	119	123	188
United States	W	W	W
Zaire	158	239	e 240
Total	r 13,687	13,222	15,176

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 produce monazite, but information is inadequate to make reliable estimates of output levels.
[2] Year beginning April 1 of that stated.
[3] Exports.

rare-earth fluoride and rare-earth oxide, however, declined to 40 tons and 25 tons, respectively.

IRE announced plans to assess the monazite content of mineral sand deposits along the Orissa coast with the possibility of constructing a mineral separation plant in Orissa similar to that at Chavara and Manavalakurichi.[13]

Indonesia.—State-owned Perussahaan Negara Tambang Timah, (P. N. Timah) planned to extract monazite and xenotime as a byproduct of tin mining. Expansion of facilities to increase tin production and separate rare-earth minerals as marketable concentrates was reported.[14]

Japan.—Brazil reportedly suspended exports of rare-earth chlorides to Japan late in the year, forcing processors to seek other sources of supply and causing at least one company, Santoku Metal Industrial Co., to modify production methods. Imports from European sources increased and Wako Bussan Co. signed a contract for the import of 1,800 tons of rare-earth chlorides from India during 1973 at $0.26 per pound, f.o.b., a 15% increase over the price paid for imports in 1972.[15] Imports of raw material from Australia are planned for 1975.

Production of cerium oxide increased from 126 tons in 1971 to an estimated 181 tons in 1972. Lanthanum oxide production likewise increased from 105 tons in 1971 to an estimated 111 tons in 1972. Shipments of cerium oxide and lanthanum oxide were about 187 tons and 118 tons, respectively.

Total consumption of rare-earth products in 1972 increased by 15% over that of 1971 to 1,384 tons. Consumption of mischmetal increased by 27% to 308 tons (165 tons for steel, 143 tons for pyrophoric alloys), yttrium oxide and europium oxide increased 24% to 23.5 tons, and cerium oxide increased 23% to 171 tons. Lanthanum oxide, however, declined 14% to 171 tons. Consumption in 1973 is projected to increase 10.5% to 1,528 tons.[16]

Development and production of rare-earth magnets continued to receive considerable attention. Tohoku Metal Industries, a producer of samarium-cobalt magnets, developed and began marketing a cheaper mischmetal magnet during the year.[17]

Shin-etsu Chemical Industry Co. Ltd., with technology supplied by Masushita Electric Industrial Co., planned production of cerium-cobalt magnets early in 1973.[18]

Sri Lanka.—The Ceylon Mineral Sands Corp. announced plans to construct an integrated mineral sand facility at Pulmoddai. The China Bay facility for the extraction of rutile and zircon would be dismantled and reconstructed at the site of the present Pulmoddai facility.[19] Upon completion, the complex will have an annual capacity of 200,000 tons of raw sand yielding 500 tons of monazite, among other heavy minerals.

South Africa, Republic of.—The Industrial Development Corp., of South Africa Ltd. (IDC) and KRC Resources S.A. Pty. Ltd., a subsidiary of King Resources, announced a joint venture to investigate a beach sand desposit containing rare-earth minerals discovered in the Richards Bay area of Natal.[20] Plans include the construction of a $455,000 pilot plant to determine the economic feasibility of the project.

Rare Earth Investments (Pty.) Ltd. was formed after the discovery of a rare-earths deposit in the Pilanesburg alkaline complex, 35 miles north of Rustenburg.[21] The deposit is estimated to contain 30 million tons of ore to a depth of 328 feet. Analyses of exposed ore veins indicate REO contents from 7.5% to 39%. Rare-earth processors in France, West Germany, and Japan are reportedly interested in the deposit.

U.S.S.R.—Kolon Trading Co., Inc., U.S. sales agent for rare-earth metals exported by Techsnabexport, Moscow, concluded an agreement for the import and sale in the United States of selected metals, including rare-earth metals, produced in the Soviet Union.[22] Total value of metals to be imported is estimated at $10 million.

---

[13] Engineering and Mining Journal. V. 174, No. 1, January 1973, p. 148.

[14] American Metal Market. Ore Deposits in Indonesia Waters. V. 79, No. 139, July 28, 1972, pp. 14–15.

[15] Japan Metal Bulletin. Imports of Crude Rare Earth Chloride to UP. No. 2942, Feb. 8, 1973, pp. 4–5.

[16] Japan Metal Journal. Demand Prospect for Rare Earth Compounds. V. 3, No. 11, Mar. 12, 1973, p. 9.

[17] Metal Bulletin. No. 5744, Oct. 24, 1972, p. 18.

[18] Japan Metal Journal. Ce-Co Magnets to be Commercially Produced. V. 3, No. 4, Jan. 22, 1973, p. 7.

[19] Sri Lanka, Ministry of Industries and Scientific Affairs. Review of Activities of Corporations 1971/1972, pp. 53–57.

[20] Engineering and Mining Journal. V. 174, No. 2, February 1973, p. 135.

[21] South African Mining & Engineering Journal. Important Rare Earth Deposit Found in the Pilanesburg. V. 84, No. 4068, May 1972, pp. 13–15.

[22] Mining Journal. U.S.–U.S.S.R. Rare Earth Deal. V. 279, No. 69, July 28, 1972, p. 69.

TECHNOLOGY

Efforts to effectively utilize the catalytic properties of rare-earth compounds received considerable attention during the year. Rare-earth oxides were demonstrated, under controlled laboratory conditions, to be effective in the oxidation of carbon monoxide in auto exhaust emission controls with lifetimes comparable to platinum, the currently favored catalyst for use in this application.[23]

The Bureau of Mines tested rare-earth oxides for catalytic activity in ethanide dehydration, nitric oxide decomposition, and the hydrogen-oxygen reaction which occurs in hydrogen-powered fuel cells. Catalytic activity varied among the six oxides tested with praseodymium showing the most favorable results.

The potentially large market for samarium-cobalt alloys has led to increased efforts to develop more efficient recovery for samarium and improved processing techniques for permanent magnet fabrication. A solvent-extraction system for recovering Sm_2O_3 from a light-group rare-earth mixture was discussed.[24] Production of samarium-cobalt magnets using a single phase sintering aid, reportedly for the first time, was announced.[25]

Results of a small pilot plant designed to test a solvent extraction technique for the coextraction of uranium and thorium thereby leaving a clear solution for possible rare-earths recovery were discussed.[26]

Bureau of Mines efforts to reduce the costs of rare-earth metals and expand applications centered around yttrium and yttrium master alloys. Electrorefining of yttrium metal from low melting yttrium-base alloys in molten halide salts was studied.[27] Yttrium alloys containing nickel, iron, and manganese were found to be suitable anode feed, whereas yttrium-copper and yttrium-magnesium alloys were not suitable starting materials. Yttrium-magnesium alloys containing up to 55 wt-% yttrium were prepared in an electrowinning cell.[28] Alloys of this type are useful as additives to other materials having rare-earth metals as minor constituents and as intermediates in the production of pure rare-earth metals. Studies of electrolytic methods for preparing yttrium-aluminum and yttrium-iron master alloys using oxide feed materials continued. The addition of small amounts of yttrium to such superalloys as Fe-Cr-Al is estimated to increase oxidation resistance by a factor of 15 to 2,100°F. Such alloys have numerous high temperature applications, including thermal reactors for automotive pollution control. A discussion of the preparation, properties, and present and potential availability of one such alloy was provided.[29] Several automotive thermal reactors using the alloy have been fabricated and made available to an automotive manufacturer for performance evaluation.

The announcement that the first X-ray laser had been developed[30] enhancing the possibility of an X-ray microscope for analyzing nuclear structures aroused considerable interest and controversy.[31] X-rays were reportedly produced when a neodymium-doped laser was focused on a sandwich of aqueous copper sulfate solution between two glass microscope covers.

Lower costs, improved quality, and increased application of rare-earth crystals may be possible as a result of a new production technique developed during the year. Gadolinium-gallium-garnet was produced by a computer controlled growing method which does not require manual control or observation.[32] In another development involving crystal growth technology

---

[23] Voorhoeve, R. J., J. P. Remeika, P. E. Freeland, B. T. Matthias (Bell Laboratories, Murray Hill, N.J.). Rare-Earth Oxides of Manganese and Cobalt Rival Platinum for the Treatment of Carbon Monoxide in Auto Exhaust. Science, v. 177, No. 4046, July 28, 1972, pp. 353–354.

[24] Bauer, D. J., L. E. Schultze, and R. E. Lindstrom. Extraction Process for Upgrading Sm_2O_3 Using Selective Stripping Techniques. BuMines RI 7663, 1972, 9 pp.

[25] American Metal Market. Sintering for Samarium-Cobalt Magnets. V. 79, No. 88, May 8, 1972, p. 20.

[26] Ritchie, G. M. and B. H. Lucas. Co-extraction of Uranium and Thorium. J. Metals, v. 24, No. 4, April 1972, pp. 39–44.

[27] Fleck, D. C., E. K. Kleespies, and D. G. Kesterke. Purification of Yttrium by Electrorefining. BuMines RI 7710, 1973, 12 pp.

[28] Aamland, E., D. J. MacDonald, and D. G. Kesterke. Molten Salt Electrowinning of Magnesium-Yttrium Alloys. BuMines RI 7722, 1973, 11 pp.

[29] Baxter, W. G. An Iron Base Alloy with Rare Earth Additions for Use in Automotive Thermal Reactors. Paper in Proc. Symp. on Environmental Control, San Francisco, Calif., Feb. 20–24, 1972, comp. by C. Rampacek. 1972, pp. 545–556.

[30] Rare Earth Information Center News. First X-Ray Laser Employs Neodymium. V. 7, No. 4, Dec. 1, 1972, p. 4.

[31] Chemical and Engineering News. Controversy Grows Over X-Ray Laser Claim. V. 51, No. 4, Jan. 22, 1972, pp. 27–28.

[32] American Metal Market. Crystals of Gadolinium Produced at Bell Labs. V. 79, No. 176, Sept. 26, 1972, p. 11.

yttrium-aluminum-garnet was grown using light from a high-pressure xenon lamp as a heat source.[33]

The expanding market for rare-earth metals as iron and steel additives continued to attract attention. The use of high-strength, low-alloy steel for specialized applications, such as arctic pipelines, requiring considerable transverse strength to withstand internal pressure and cold represents a substantial market for rare-earth metals. The mechanical properties of a steel composition recommended by Molycorp, containing mischmetal to control sulfide shape for desulfurization, were evaluated.[34] Yield strength, transition temperature, and ductile fracture energy values were found to meet arctic gas pipeline requirements.

The effect of mischmetal additives on commercially produced Ni-Cr-Mo steel was studied.[35] Transverse toughness was improved but the rare-earth additive had no effect on temper embrittlement, although the increased toughness offset much of the embrittlement tendency. In a discussion of die casting alloys, mischmetal was reportedly more effective than silicon in improving creep resistance as the aluminum content of magnesium die casting alloys decreased.[36]

The growing concern over an impending energy shortage and pollution of the environment by conventional fuels has increased interest in other forms of energy, including hydrogen. Hydrogen can be stored as a gas under pressure or in liquid form although such storage presents large-scale distribution, safety, and end-use problems. Evaluation of a storage system using hydrides based upon rare-earth-transition metal compounds, among other materials, to absorb hydrogen for subsequent release by lowering the pressure or raising the temperature, is planned.[37]

Magnetic bubbles were observed for the first time in amorphous films made of gadolinium-cobalt and gadolinium-iron. Such films, used for computer circuits, can be deposited on such materials as flexible plastics and are reportedly cheaper and easier to make than the crystalline variety.[38]

---

[33] Chemical and Engineering News. V. 50, No. 36, Sept. 4, 1972, p. 14.

[34] Gray, J. Malcolm and William G. Wilson. Molycorp Develops X-80 Arctic Pipeline Steel. Pipeline & Gas J., v. 199, No. 4, December 1972, pp. 50, 52, and 66.

[35] Sprung, I. R. and K. R. Olen. Temper Embrittlement Response and Toughness of an Rare Earth Treated Ni-Cr-Mo Steel. Metallurgical Trans., v. 3, No. 11, November 1972, pp. 2939–2941.

[36] Foerster, George. Designing Die Casting Alloys. Light Metal Age, v. 30, No. 9, 10, October 1972, pp. 10–13. Abstract of paper pres. at the 7th Society of Die Casting Engineers, International Die Casting Congress, Oct. 16–19, 1972.

[37] Chopey, Nicholas P. Hydrogen: Tomorrow's Fuel? Chem. Eng., v. 79, No. 29, Dec. 25, 1972, pp. 24–26.

[38] Chemical and Engineering News. V. 51, No. 7, Feb. 12, 1973, p. 11.

Rhenium

By Larry J. Alverson [1]

Domestic rhenium production decreased but was adequate to meet the more greatly reduced demand for bimetallic platinum-rhenium catalysts, rhenium's major end use. As a result of decreased demand, there was a decline in the price of both metal powder and compounds, and an increase in stocks. Substitution of other metals for rhenium in bimetallic catalysts was primarily responsible for the decreased demand. The rhenium supply was augmented during the year by the importation of a significant amount of ammonium perrhenate (NH_4ReO_4), primarily from Sweden, the United Kingdom, and West Germany.

DOMESTIC PRODUCTION

Production of rhenium, a secondary byproduct material recovered primarily from molybdenite (MoS_2) associated with southwestern U.S. and Chilean porphyry copper ores, decreased in 1972 to an estimated 6,100 pounds of rhenium contained in rhenium salts. Cleveland Refractory Metals (CRM), a subsidiary of Kennecott Copper Corp., remained the leading rhenium producer in the United States. The company processed domestic molybdenite concentrates from operations of Kennecott and Magma Copper Co., a subsidiary of Newmont Mining Corp., as well as concentrates from Chilean sources, at its Garfield, Utah, roasting facility.

During 1972, Continental Rhenium Corp., a wholly owned subsidiary of Continental Ore Corp., became the nation's fifth rhenium producer, processing MoS_2 concentrate from Arizona, Canada (British Columbia), Chile, and Peru, at the corporation's Golden, Colo., plant. Preliminary information indicates recoveries in excess of 95% have been achieved due to the application of a new patented process (see technology section) for recovering rhenium.

Production of rhenium bearing molybdenite from porphyry copper ore continued at Magma's San Manuel mine in Pinal County, Ariz. M&R Refractory Metals, Inc., at its Winslow, N.J., plant, produced rhenium salts from the MoS_2 of Magma's San Manuel copper operations for Engelhard Minerals & Chemicals Corp. on a contract-conversion basis. Shattuck Chemical Co., Denver, Colo., a division of Engelhard Minerals & Chemicals Corp., recovered rhenium salts from Arizona molybdenite concentrates. Molybdenum Corp. of America (Molycorp) recovered rhenium salts from MoS_2 concentrate associated with porphyry copper ores in Arizona and primary molybdenite from the Questa molybdenum mine in New Mexico. Molycorp de-

[1] Industry economist, Division of Ferrous Metals.

Table 1.—Salient rhenium statistics

(Pounds of contained rhenium)

	1970	1971	1972
Mine production e	5,900	7,250	6,100
Consumption e	5,100	7,600	4,300
Imports (metal and scrap)	210	377	168
Imports (ammonium perrhenate) e	857	3,547	1,183
Stocks, Dec. 31 e	r 6,400	r 9,900	13,000

e Estimate. r Revised.

veloped a new hydrometallurgical process to produce molybdenum and rhenium compounds. This process, developed in cooperation with the Colorado School of Mines Research Institute, prevents sulfur dioxide (SO_2) pollution of the atmosphere, which occurs in conventional roasting of molybdenite. The new process is reportedly unique in its ability to produce high purity products at high yield from substandard MoS_2 source material and has been successfully tested in a small production unit for several months. Molycorp applied for patents throughout the world and was holding licensing discussions with interested companies in the United States and Europe at yearend. The rhenium facilities at Washington, Pa., operating at minimal rates during the first half of 1972, were put on standby and remained that way for the remainder of the year owing to prevailing market conditions.

Newmont Exploration Ltd., a subsidiary of Newmont Mining Corp., installed a multihearth furnace for controlled atmosphere roasting tests at its Danbury, Conn., metallurgy research center as part of its research into a new method of molybdenum-rhenium separation. Much of the work will involve studies of molybdenite concentrate roasting. The molybdenite from the San Manuel mine of Newmont's wholly owned Magma Copper Co. has a high rhenium content, and a new roasting process could yield greater returns than currently obtained by selling concentrate to others for treatment.[2]

Other domestic molybdenite roasting facilities that might be adapted for rhenium recovery include those of Climax Molybdenum Co. at Langeloth, Pa., Duval Corp. at Mineral Park, Ariz., Duval-Sierrita Corp. at Esperanza, Ariz., and Republic Steel Corp. at Canton, Ohio.

CONSUMPTION AND USES

Approximately 85% of estimated 1972 rhenium metal consumption of 4,300 pounds was used in alumina-based bimetallic platinum-rhenium catalysts for refining unleaded, high-octane gasoline. Atmospheric pollution considerations during the last few years have given this application added impetus; however, in 1972, consumption decreased considerably, owing primarily to the substitution of other metals (probably mostly iridium) for rhenium in bimetallic catalysts.

Engelhard Minerals & Chemicals Corp. developed a new series (E-600) of platinum-rhenium catalysts that initially prove to have better stability, better yield as activity declines, and an unlimited number of regenerations and reactivations without significantly impairing catalyst performance. Algeria and the Soviet Union contracted to use the new catalyst in major new complexes in their respective countries.[3] The E-600 series catalysts supplements the older E-500 series catalysts, which are extensively used in the free world's reformers.

Mowhawk Petroleum Corp. completed 3 years of operation using Universal Oil Product's (UOP) bimetallic platinum-rhenium catalyst, type R–16, without a single regeneration or shutdown for catalyst screening. The catalyst service at the end of this first cycle was equivalent to 300 barrels of naphtha per pound of catalyst. The charge rate during the 3 years of operation was essentially constant at 2,600 barrels of naphtha per stream-day.[4]

Two refiners, one Japanese and one domestic, have agreed to use Chevron's new type "D" catalyst for the manufacture of high-octane gasoline-blend stocks in new Rheniforming installations. Presently 29 refineries in the United States, Canada, Europe, and Japan are using type "A" and "B" Rheniforming catalysts.[5]

There are seven low-pressure (200 pound per square inch gauge) Rheniformers currently in service with a total capacity of 120,000 barrels per day.[6] Presently, approximately one quarter of all petroleum reforming catalysts are of the bimetallic platinum-rhenium variety.

The straight platinum (monometallic) catalysts are rapidly being replaced by bi-

[2] Newmont Mining Corp. Annual Report 1972, 32 pp.
[3] Engelhard Minerals & Chemicals Corp. Annual Report 1972, 28 pp.
[4] The Oil and Gas Journal. Bimetallic Pays Off in 3-Year Run. V. 70, No. 36, Sept. 4, 1972, pp. 80–81.
[5] The Oil and Gas Journal. Chevron Develops New Catalyst. V. 70, No. 47, Nov. 20, 1972, p. 48.
[6] The Oil and Gas Journal. Cat-Reforming Pressure Drops Again. V. 70, No. 20, May 15, 1972, pp. 124–136.

metallic catalysts such as platinum-rhenium. However, research is continuing to find substitutes for the rhenium part of the catalyst. Gold, gallium, germanium, indium, and iridium are being tested and evaluated as replacements for rhenium. Iridium seems to have gained a foothold in the market, notably with the introduction by Exxon Research of its new KX–130 "multimetallic" reforming catalyst containing platinum, iridium, and possibly a third element.[7]

The remaining 15% of estimated domestic rhenium consumption was in X-ray tubes, refractory-metal alloys, high-temperature thermocouples, temperature controls, electronic devices, vacuum tube and flashbulb filaments, coatings, electrical contacts, and research and development.

Tungsten-rhenium thermocouples are experiencing increased usage for high temperature measurement, other than that in a nuclear environment, which use has been recently found to be better served by tungsten-molybdenum thermocouples, which exhibit less deterioration. It appears that tungsten-rhenium thermocouples may find additional application in measuring and controlling combustion chamber exhaust temperatures of turbine engines.

During the 1969–71 period, there was a decline in the use of fabricated devices of rhenium owing to curtailment of aerospace programs; however, rhenium is currently finding increased usage in the fabrication of devices for use in X-ray tubes.

A Bureau of Mines Information Circular was published in early 1973 that contains information on rhenium from geologic background and analysis to supply-demand patterns and trends.[8]

PRICES

Prices paid for rhenium metal powder used in rhenium metal wire and mill products during the year ranged from about $975 to $1,400 per pound, depending on quantity, decreasing toward the former by yearend. Prices paid for perrhenic acid used in catalytic applications ranged from about $875 to $1,350 per pound, trending toward the former in the second half of the year.

During the year, the country's leading rhenium producer, quoted rhenium metal powder and perrhenic acid prices closely within these ranges. In August, Shattuck Chemical Co. cut its price on rhenium metal powder to $975 per pound, and that on perrhenic acid to $875 per pound. The company claimed that its price reductions were made possible by its recent plant expansion.

FOREIGN TRADE

Imports of unwrought rhenium metal during 1972 decreased 55% from that of 1971, and totaled 168 pounds valued at $125,751. These imports, all of which represented rhenium metal powder, came from West Germany (85%), and France (15%). There were no imports of scrap or wrought rhenium metal during the year. Unwrought rhenium imports are believed to have been recovered from byproduct molybdenite obtained from porphyry copper ore mined in Chile. The average price of unwrought rhenium metal imports, excluding U.S. duty, was $749 per pound, and ranged from $713 per pound (West Germany), to $952 per pound (France).

A significant amount of rhenium in the form of ammonium perrhenate (NH_4ReO_4) salts was imported primarily from Sweden, the United Kingdom, and West Germany. This material imported under the basket classification "Ammonium Compounds, not specifically provided for" (TSUS 417.44), totaled approximately 1,183 pounds of contained rhenium, valued at $1,357,078.

The import duty on rhenium metal from non-Communist countries remained at the January 1, 1972, rate of 5% ad valorem for unwrought rhenium metal and scrap, and 9% ad valorem for wrought rhenium metal. The import duty on wrought and unwrought rhenium metal from Communist Bloc countries also remained unchanged at 45% ad valorem and 25% ad valorem, respectively. The duty on

---

[7] Chemical Week. Catalysts. V. 111, No. 18, Nov. 1, 1972, pp. 23–33.

[8] Shimamoto, K. Availability of Rhenium in the United States. BuMines IC 8573, 1973, 30 pp.

imports of ammonium perrhenate from Communist and non-Communist countries was 25% ad valorem and 4% ad valorem, respectively.

The import duty on waste and scrap remained temporarily suspended until June 30, 1973.

Table 2.—U.S. imports for consumption of rhenium (including scrap), by country

(Gross weight)

Country	1970 Pounds	1970 Value	1971 Pounds	1971 Value	1972 Pounds	1972 Value
Belgium-Luxembourg	--	--	220	$262,278	--	--
France	58	$53,789	45	49,770	25	$23,796
Germany, West	79	34,373	110	140,000	143	101,955
U.S.S.R.	73	23,467	--	--	--	--
United Kingdom	--	--	2	794	--	--
Total	210	111,629	377	452,842	168	125,751

Table 3.—Estimated imports for consumption of rhenium salts, by country [1]

(Gross weight)

Country	1970 Pounds	1970 Value	1971 Pounds	1971 Value	1972 Pounds	1972 Value
Germany, West	171	$114,909	2,016	$1,545,347	568	$488,519
Japan	44	25,439	20	15,103	223	108,291
Sweden	1,027	658,933	2,965	2,201,568	687	563,506
United Kingdom	--	--	140	113,431	236	196,762
Total	1,242	799,281	5,141	3,875,449	1,714	1,357,078
Total (rhenium content)	857	799,281	3,547	3,875,449	1,183	1,357,078

[1] Figures are derived from the basket category "Ammonium compounds not specifically provided for" (TSUS 417.44).

WORLD REVIEW

Canada.—The Island Copper mine of Utah International Inc., (UI) on Rupert Inlet near Port Hardy, British Columbia, which contains some of the richest known rhenium concentrations in the world, continued to market rhenium and molybdenum concentrates. Two hundred and fifty tons of molybdenum concentrate was sold in 1972, about 14% of designed capacity. In some cases the molybdenum buyer purchased the contained rhenium, while in others, the rhenium was returned on a "toll" basis in order for UI to seek prospective buyers.[9] The estimated rhenium content of the ore body based on copper ore reserves of 280 million tons with 0.53% copper and about 0.027% MoS_2, is over 270,000 pounds, assuming 90% recovery of rhenium from molybdenite.

The Lornex mine of Rio Algom Mines, Ltd., a subsidiary of the Rio Tinto-Zinc Corp., situated in the Highland Valley area of British Columbia, is Canada's newest and largest open pit copper-molybdenum producer. Estimates of the ore body indicate reserves of 293 million tons of ore averaging 0.43% copper and 0.014% MoS_2.[10] Rhenium is present in the ore body but its content has not been established. However, using the rhenium content of nearby operations as a rough base, an estimated rhenium content of about 75,000 pounds can be inferred.

Chile.—A new rhenium plant at Concepción was scheduled to come onstream in 1974–75. A Western European firm together with Cía. de Acero del Pacífico S.A., (CAP) financed a successful pilot plant at the Hazen Research Center in the United States. The industrial plant will be designed to deliver high-grade molybdenum chemicals with the byproduct rhenium as either a chemical-grade rhenium salt or perrhenic acid ($HReO_4$). The pro-

[9] Utah International Inc. Annual Report 1972. 32 pp.
Mining Engineering. Island Copper Starts Up. V. 24, No. 7, July 1972, p. 8.

[10] Mining Magazine. Lornex. V. 128, No. 3, March 1973, pp. 154–163.

duction target calls for a yearly rhenium output of 3,300 pounds.[11]

The privately owned Chilean firm Carburo y Metalurgia S.A. (Carbomet) has been producing a technical-grade ammonium perrhenate (NH_4ReO_4) since December 1970. The firm is currently enlarging its plant facilities in Nos, Santiago, to increase rhenium capacity in 1973 from 2,000 to 2,700 pounds per year of rhenium contained in technical-grade ammonium perrhenate salt.[12]

Chilean molybdenum and rhenium resources show about 7,700 pounds per year of rhenium as a recoverable figure from the three big State-owned porphyry copper mines. There are additional potentially important rhenium resources from new Chilean porphyry copper deposits, such as Mocha, Cerro Colorado, El Abra, Andacollo, Loica, Pelambres, and others.

The Corporación del Cobre (CODELCO) announced commencement of feasibility studies on a plant to extract molybdenum, rhenium, and other rare metals from porphyry copper ore of the recently nationalized (1971) Rio Blanco copper deposit. The deposit was previously worked by the Cerro Corp. of the United States. According to CODELCO, the plans envisage a $2.6 million plant to be established in the Rio Blanco region about 90 miles northeast of Santiago. The plant is expected to become operational by mid-1973.[13]

Japan.—Shiba, Japan, is the site of Engelhard's newly commissioned magnaformer installation, utilizing the greatly improved E–601 platinum-rhenium bimetallic catalyst for the manufacture of unleaded, high-octane gasoline.[14]

Taiyo Mining and Industrial Co., Ltd., was granted an exclusive license for use of a new hydrometallurgical process developed by Molycorp to produce molybdenum oxide and rhenium compounds.

Mongolia.—The giant copper-molybdenum deposit at Erdenetiyn-ovoo was first investigated by a joint Mongol-Czechoslovak geologic expedition in 1964–65. In 1970, rhenium and other metals were identified in the deposit; however, the rhenium content has not yet been assayed. A new agreement with the Soviet Union for the exploitation of the deposit seems imminent.[15]

TECHNOLOGY

The Bureau of Mines electrooxidation technique was successfully applied to the recovery of molybdenum and rhenium from sulfide ores and concentrates at its Reno Metallurgy Research Center. Extraction of 99% of the molybdenum and rhenium was found to be feasible on a bench scale with an immersion-type electrode system. Similar results were obtained in larger experiments using a 1,260-ampere, bipolar, flow-through cell, except that the power requirements per pound of molybdenum were substantially reduced. This process eliminates the use of the conventional roasting techniques, which are the main factors contributing to sulfur dioxide pollution of the atmosphere.

Concomitant studies on the extraction and separation of molybdenum and rhenium from process solutions have resulted in development of an amine extraction-carbon adsorption system that is capable of recovering 99% of the rhenium as 99.99%-pure ammonium perrhenate, and 99% of the molybdenum as high-purity ammonium molybdate.

The Bureau also investigated hydrometallurgical processing of low-grade molybdenite rougher flotation concentrates as a means for improving byproduct molybdenum and rhenium recovery from porphyry copper ores. Several methods were investigated, and the best rhenium and molybdenum recoveries from the leach liquor were obtained by adsorption of the rhenium from the basic liquor with an anion exchange resin, acidification of the residual liquor, followed by recovery of the molybdenum by adsorption with activated charcoal. The rhenium was recovered from the loaded resin by stripping with ammonium thiocyanate.

Kennecott Copper Corp. received a patent for a process that simultaneously reduces atmospheric pollution and recovers

---

[11] Metals Sourcebook No. 9. Other Metals. May 7, 1973, p. 2.

[12] Intermet Bulletin. Rhenium Production in Chile. V. 2, No. 3, January 1973, p. 35.

[13] The Mining Journal (London). Chile: New Plant? V. 278, No. 7136, May 26, 1972, p. 433.

[14] Work cited in footnote 3.

[15] Far Eastern Economic Review. Precious Cairn. V. 80, No. 14, Apr. 9, 1973, p. 24.

rhenium values in the gaseous effluent from copper smelting operations. The process involves scrubbing volatilized rhenium oxide and sulfur oxide with an aqueous alkaline solution to remove most of the sulfur oxide from the gas stream as a soluble sulfite and to dissolve the rhenium oxide in the resulting sulfite solution. The rhenium-bearing sulfite solution is treated by known means, such as ion exchange or solvent extraction, to recover the contained rhenium oxide.[16]

A patent was issued to Continental Ore Corp. for recovery of rhenium and molybdenum values from solution. The process involves extracting soluble molybdenum and rhenium values with an amine solvent, and stripping the values from the amine extract with an ammonium hydroxide solution. The rhenium is then concentrated and recovered from the crystallization mother liquor by amine solvent extraction. It is stripped from the resin using a sodium hydroxide solution and extracted into a pyridine solvent, which is distilled away leaving the desired rhenium salt.[17]

Early in the year, a patent was granted for a process that regenerates deactivated platinum-rhenium reforming catalysts to the condition of fresh reforming catalysts.[18] Dependent on its cost and applicability, this or similar processes should attract the interest of many catalyst manufacturers and petroleum-refining companies.

Chevron Research Co., a subsidiary of Standard Oil of California, developed a new catalyst known as Rheniforming type "D" to help refineries meet no-lead and low-lead motor fuel requirements. The new catalysts reportedly will cost less, provide better yields, have greater stability, and require smaller amounts of platinum.[19]

Kennecott Copper Corp. was granted a patent on a new process for extracting molybdenum and rhenium from raw materials. In the process, molybdenum and rhenium values are recovered from molybdenite concentrate by roasting in the presence of calcium compounds to produce water-insoluble calcium molybdate and water-soluble calcium perrhenate. The need for extensive gas-cleaning equipment to prevent SO_2 discharge is eliminated by the process. The calcine is leached with water to separate rhenium from the molybdenum values, and then leached with acid to solubilize the molybdenum. Alternatively, the calcine is leached with acid, and the dissolved rhenium and molybdenum values may be recovered separately from the clarified solution by use of extraction and stripping cells and/or ion-exchange resins.[20]

A process was patented for the removal of rhenium and other metallic impurities from a sulfide-bearing molybdenite ore. The process, which does not evolve sulfur dioxide, thus eliminating a potential air pollution problem, comprises (1) roasting ore with alkali metal carbonate, (2) leaching 95% of the molybdenum from the resulting fusion mass, (3) oxidizing the leached mass, and (4) treating it with water to extract the rhenium and molybdenum from other metallic impurities before recovering the rhenium and molybdenum by conventional procedures.[21]

Engelhard Minerals & Chemical Corp. studied tungsten-rhenium thermocouple junctions to determine how and under what circumstances tungsten-rhenium wire could be joined and still maintain adequate handleability. It was found that a reliable, sound, and handleable thermocouple junction can be obtained by tightly twisting tungsten-rhenium wire and welding the ends. To be effective, there must be at least one and one half turns of wire prior to the weld. Repeated tests with over 75 junctions fabricated by this technique have resulted in no failures traceable to a properly executed twist.[22]

A study was carried out in the Ledgemont Laboratory of Kennecott Copper Corp. on the oxidative vaporization of

---

[16] Spedden, H. R. (assigned to Kennecott Copper Corp., New York). Process for Recovering Volatilized Rhenium Oxides and Sulfur Oxides From Gas Streams. U.S. Pat. 3,723,595, Mar. 27, 1973.

[17] Litz, J. E. (assigned to Continental Ore Corp., New York). Recovery of Rhenium and Molybdenum Values From Solution. U.S. Pat. 3,681,016, Aug. 1, 1972.

[18] Moravec, Jr. V. J. Regeneration of Platinum-Rhenium Reforming Catalyst. U.S. Pat. 3,654,142, Apr. 4, 1972.

[19] Work cited in footnote 5.

[20] Noy, J. M. (assigned to Kennecott Copper Corp., New York). Process for Extracting Molybdenum and Rhenium From Raw Materials Containing Same. U.S. Pat 3,705,230, Dec. 5, 1972.

[21] Martin, B. E., M. B. MacInnis (assigned to GTE Sylvania, Inc., Seneca Falls, N.Y.). Rhenium and Molybdenum Separation From Sulfide Ores. U.S. Pat. 3,725,524, Apr. 3, 1973.

[22] American Metal Market. Tungsten-Rhenium Thermocouple Use Widening. V. 79, No. 14, Nov. 22, 1972, p. 14A.

rhenium from natural molybdenite concentrates under controlled conditions. The molybdenite oxidation and rhenium vaporization were measured, respectively, by the amount of SO_2–SO_3 and by the amount of rhenium collected in an aqueous absorber as a function of time. The rate of rhenium vaporization increased with the oxygen content of the reactant gas. Consistent with the molybdenite oxidation, rhenium volatilization increased markedly with temperature. The experiments confirmed the general relationship between rhenium vaporization and molybdenite oxidation. With the volatility of rhenium shown under ideal conditions, it is suggested that in multiple hearth roasters, there is oxidation and vaporization in the lower hearths followed by reduction and recondensation of rhenium in the upper stages.[23]

[23] Amman, P. R., and T. A. Loose. Rhenium Volatilization During Molybdenite Roasting. Met. Trans., v. 3, No. 4, April 1972, pp. 1020–1022.

Salt

By Robert T. MacMillan [1]

Production of salt in 1972 declined slightly for the second consecutive year following a 12-year period of steady growth. The quantity actually sold or used by producers, however, increased 2% compared with the 1971 figures. This increase was attributed to a large inventory of unused rock salt carried over from the previous year. The average value of salt sold or used in 1972 declined 4% compared with the 1971 value.

Exports increased 30% in quantity and 33% in value compared with corresponding 1971 figures. Imports, however, declined 10% in quantity and 17% in value.

Legislation and Government Programs.—Tightened antipollution standards set by Federal and State environmental pollution control agencies resulted in the final closing of Olin Corp.'s chlorine-caustic soda plant, Virginia's lone salt producing company. The cost of modernizing the plant to meet more stringent effluent standards was considered too high, and production was phased out early in 1972.

Table 1.—Salient salt statistics

(Thousand short tons and thousand dollars)

	1968	1969	1970	1971	1972
United States:					
Production	NA	NA	[1] 46,764	[1] 44,700	[1] 44,010
Sold or used by producers	41,274	44,245	[1] 45,896	[1] 44,077	[1] 45,022
Value	272,275	287,680	304,759	303,687	296,772
Exports	728	716	423	670	869
Value	4,650	4,486	3,657	4,182	5,544
Imports for consumption	3,456	3,302	3,536	3,855	3,463
Value	11,487	11,990	13,329	14,429	11,979
Consumption, apparent	44,002	46,831	49,009	47,262	47,616
World: Production	138,426	150,495	161,081	158,931	162,560

NA Not available.
[1] Excluding Puerto Rico; 32,000 short tons (1970), 28,500 short tons (1971) and 29,000 short tons (1972).

DOMESTIC PRODUCTION

Seventeen States recorded salt production in 1972. The two leading States, Louisiana and Texas, produced 52% of the total output. Ohio, New York, and Michigan contributed 36%. Salt was produced by 54 companies at 96 plants in the United States and Puerto Rico in 1972. Eleven companies, each producing more than 1 million tons in 1972, operated 42 plants and accounted for 85% of the total salt output. Eighteen companies with a production of less than 1 million tons but more than 100,000 tons operated 28 plants and accounted for 14% of the total production. Twenty-five other companies whose individual production was less than 100,000 tons operated 26 plants and supplied the remaining 1% of the total salt output.

Fifteen plants, each with a production of over 1 million tons, accounted for 64% of the total salt output. Ten plants, each producing between 500,000 and 1 million tons, accounted for 14% of the total. The remaining 22% was supplied by 71 plants.

A trend toward consolidation in the salt industry continued with Solar Salt Co. of Utah being sold to American Salt Corp. Dakota Salt Co. of North Dakota was ac-

[1] Physical scientist, Division of Nonmetallic Minerals.

Table 2.—Salt sold or used by producers in the United States, by method of recovery

(Thousand short tons and thousand dollars)

Recovery method	1971 Quantity	1971 Value	1972 Quantity	1972 Value
Evaporated:				
Bulk:				
Open pans or grainers	335	8,745	388	13,225
Vacuum pans	3,289	86,478	3,287	85,081
Solar	1,937	21,432	1,799	15,115
Pressed blocks	367	10,532	376	10,927
Total [1]	5,928	127,186	5,850	124,348
Rock:				
Bulk	13,613	87,226	14,369	88,903
Pressed blocks	87	2,095	66	2,138
Total [1]	13,700	89,321	14,434	91,041
Salt in brine (sold or used as such)	24,449	87,180	24,737	81,383
Grand total [1]	44,077	303,687	45,022	296,772

[1] 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	1971 Quantity	1971 Value	1972 Quantity	1972 Value
California	1,887	21,142	1,621	14,860
Kansas [1]	1,240	18,712	1,369	20,562
Louisiana	13,352	67,950	13,514	67,464
Michigan	4,458	49,007	4,358	50,761
New Mexico	146	1,130	W	W
New York	5,303	43,601	5,604	43,866
Ohio	5,709	46,651	6,147	47,710
Texas	9,217	40,838	9,744	36,544
Utah	614	5,213	660	4,955
West Virginia	1,174	4,778	1,232	5,963
Other States [2]	976	4,667	771	4,087
Total [3]	44,077	303,687	45,022	296,772
Puerto Rico	29	570	29	580

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, Colorado, Hawaii, Kansas (brine only), Nevada, North Dakota, Oklahoma, Virginia, and States 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	1971 Quantity	1971 Value	1972 Quantity	1972 Value
California	1,592	20,164	1,355	13,980
Kansas	676	15,847	723	17,207
Louisiana	275	9,899	269	8,840
Michigan	1,174	30,042	1,169	32,562
New York	658	19,842	600	18,015
Ohio	763	21,072	806	22,174
Other States [1]	790	10,819	930	11,571
Total [2]	5,928	127,186	5,850	124,348
Puerto Rico	29	570	29	580

[1] Includes Hawaii, Nevada, New Mexico, North Dakota, Oklahoma, Texas, and Utah.
[2] Data may not add to totals shown because of independent rounding.

quired by Hardy Salt Co. of Michigan, and Diamond Crystal Salt Co. of Michigan was sold to Oglebay Norton Co. Olin Corp. closed down its salt well facilities at Saltville, Va., after many years of chlorine and caustic soda production. The soda ash plant was closed in 1971. Cargill, Inc. closed its Pawnee Salt Co. in Kansas and its equipment was transferred to Cargill's Gordy plant at Baldwin, La.

Table 5.—Rock salt sold by producers in the United States

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1968	12,461	79,867
1969	13,397	86,452
1970	14,170	95,291
1971	13,700	89,321
1972	14,434	91,041

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 [1]	
	Quantity	Value	Quantity	Value	Quantity	Value
1968	357	9,246	85	2,321	442	11,567
1969	369	9,622	83	2,352	452	11,974
1970	368	10,085	79	2,269	447	12,353
1971	367	10,532	87	2,095	454	12,627
1972	376	10,927	66	2,138	442	13,065

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

CONSUMPTION AND USES

Of the total salt consumed in 1972, 54% was consumed as brine, 33% as rock salt, and 13% as evaporated salt. The production of chlorine required 45% of the total salt output, soda ash manufacturing required 13%, and all other chemicals re-

Table 7.—Salt sold or used by producers in the United States, by class and consumer or use

(Thousand short tons)

Consumer or use	1971				1972			
	Evaporated	Rock	Brine	Total [1]	Evaporated	Rock	Brine	Total [1]
Chlorine	282	2,733	16,605	19,621	302	2,706	17,718	20,726
Soda ash	1	(2)	6,357	6,358	W	W	5,786	5,791
Soap (including detergents)	24	W	W	27	22	5	(2)	27
All other chemicals	426	346	487	1,259	440	479	117	1,036
Textile and dyeing	118	75	--	193	132	75	--	207
Meatpackers, tanners, casing manufacturers	283	370	--	653	266	353	--	619
Fishing	33	4	--	37	42	4	--	45
Dairy	55	6	--	61	56	24	--	80
Canning	185	55	(2)	241	160	68	(2)	228
Baking	110	6	--	116	110	7	--	117
Flour processors (including cereal)	68	11	(2)	79	70	12	(2)	83
Other food processing	475	40	(2)	515	483	37	(2)	520
Ice manufacturers and cold storage companies	1	2	--	4	1	2	--	3
Feed dealers	862	493	--	1,355	933	453	(2)	1,386
Feed mixers	329	258	--	586	354	223	--	577
Metals	47	135	(2)	182	W	175	W	227
Ceramics (including glass)	4	4	--	8	4	3	--	7
Rubber	74	W	W	172	86	W	W	173
Oil	54	60	51	164	47	62	93	202
Paper and pulp	105	115	59	279	W	125	W	201
Water softener manufacturers and service companies	418	W	W	680	350	W	W	698
Grocery stores	795	441	--	1,236	802	456	(2)	1,258
Railroads	1	2	--	3 }				
Bus and transit companies	1	3	--	3 }	1	4	--	6
Highway use	331	7,571	4	7,905	464	8,787	4	9,255
U.S. Government	24	34	(2)	59	26	65	(2)	91
Miscellaneous [3]	1,074	620	792	2,487	705	555	809	2,069
Total [1]	[4]6,180	[4]13,640	[4]24,463	[5]44,283	[4]5,926	[4]15,044	[4]24,664	[5]45,634

W Withheld to avoid disclosing individual company confidential data; included with "Total."
[1] Data may not add to totals shown because of independent rounding.
[2] Less than ½ unit.
[3] Includes 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, 2, and 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	1971		1972	
	Evaporated	Rock	Evaporated	Rock
Alabama	52	329	50	407
Alaska	W	W	W	--
Arizona	28	W	36	1
Arkansas	20	89	21	97
California	1,193	82	915	146
Colorado	106	51	113	46
Connecticut	19	129	17	W
Delaware	7	196	6	W
District of Columbia	5	31	4	W
Florida	41	135	41	124
Georgia	62	248	61	263
Hawaii	4	--	W	--
Idaho	51	W	57	1
Illinois	341	870	353	1,304
Indiana	154	416	159	555
Iowa	196	307	200	340
Kansas	80	222	89	189
Kentucky	47	516	48	517
Louisiana	52	380	52	449
Maine	10	172	9	W
Maryland	47	74	44	W
Massachusetts	46	481	77	W
Michigan	190	463	204	W
Minnesota	151	371	150	307
Mississippi	21	102	19	114
Missouri	99	294	111	356
Montana	51	1	58	1
Nebraska	106	83	119	93
Nevada	33	211	31	W
New Hampshire	7	162	W	W
New Jersey	158	531	157	408
New Mexico	43	68	51	45
New York	313	1,666	326	2,021
North Carolina	132	178	125	148
North Dakota	27	4	35	W
Ohio	351	1,361	371	1,300
Oklahoma	40	61	41	66
Oregon	W	W	41	W
Pennsylvania	192	1,114	186	996
Rhode Island	10	82	15	W
South Carolina	37	25	40	21
South Dakota	53	27	56	28
Tennessee	120	535	122	557
Texas	95	187	322	237
Utah	313	W	108	W
Vermont	6	156	6	W
Virginia	103	147	99	108
Washington	161	W	120	(1)
West Virginia	22	161	23	136
Wisconsin	176	544	178	716
Wyoming	20	3	29	3
Other [2]	591	373	431	2,945
Total [3] [4]	6,180	13,640	5,926	15,044

W Withheld to avoid disclosing individual company confidential data; included with "Other."

[1] Less than ½ 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.

quired 2%, totaling 60% for the chemical industry as a whole in 1972. This compared with 61% for the previous year.

The second largest use of salt was for deicing streets and highways and for roadbed stabilization. This use, which is tabulated in table 7 opposite "Highway use," formerly "States, counties, and other political subdivisions (except Federal)," required 20% of the salt output in 1972 compared with 18% in the previous year.

Salt used for food and food-related uses was 6.5% of the total consumed compared with 6.4% in 1971. The categories included in food-related consumption were as follows: Meat packers, tanners, etc.; fishing, dairy, canning, and baking; flour processing; other food processing; and grocery stores. Salt sold to grocery stores was assumed to be largely for table use; however, some salt in this category may have been used for water softeners.

PRICES

Prices per 100 pounds of salt quoted in Chemical Marketing Reporter for various grades in 1972 were as follows:

	January	June	July	December
Salt, evaporated, common, in bags, carlots, or truck lots, works	$1.43	$1.43	$1.43	$1.43
Salt, chemical-grade, same basis	1.54	1.54	1.54	1.54
Salt, rock, medium, coarse, same basis	.97	.97	.97	.97
Salt, rock, extra coarse, same basis	1.02	1.02	1.02	1.02

The average value of evaporated salt reported by producers to the Bureau of Mines in 1972 was $21.26 per ton. On the same basis the average value of rock salt was $6.31, and that of salt in brine was $3.29.

FOREIGN TRADE

Exports of salt increased 30% in 1972, compared with the 1971 figure, but were less than 2% of the total production. Canada and Japan were the chief recipients. Exports to Canada increased 58%, and exports to Japan decreased 15%.

Imports of salt decreased 10% in volume and 17% in value in 1972 compared with corresponding figures in 1971. Mexico became the chief supplier with 36% of the total; Canada, formerly our chief supplier, was second with 29%; and Bahamas with 25% was third. The remaining 10% came from several countries. Imports were 7.3% of the apparent consumption for the United States in 1972.

Table 9.—Salt shipped to the Commonwealth of Puerto Rico and overseas areas administered by the United States

Area	1971		1972	
	Short tons	Value (thousands)	Short tons	Value (thousands)
American Samoa	199	$11	545	$23
Puerto Rico	19,060	1,856	20,055	2,247
Virgin Islands	150	31	478	33

Table 10.—U.S. exports of salt, by country

(Thousand short tons and thousand dollars)

Destination	1971		1972	
	Quantity	Value	Quantity	Value
Australia	(1)	34	(1)	9
Bahamas	2	70	2	86
Canada	398	2,350	627	3,780
Costa Rica	1	25	1	29
Honduras	(1)	20	1	23
Japan	260	1,100	220	924
Mexico	1	59	3	68
Netherlands Antilles	2	87	1	64
New Zealand	1	37	1	36
Panama	1	31	1	49
Philippines	(1)	16	2	16
Saudi Arabia	1	70	1	141
South Africa, Republic of	1	16	2	17
Trinidad and Tobago	(1)	3	1	13
Other	2	264	6	289
Total	670	4,182	869	5,544

[1] Less than ½ unit.

Table 11.—U.S. imports for consumption of salt, by country

(Thousand short tons and thousand dollars)

Country	1971 [1]		1972	
	Quantity	Value	Quantity	Value
Bahamas	865	3,328	875	3,429
Canada	1,457	7,059	1,001	4,581
Chile	280	873	182	493
Ireland	60	148	--	--
Mexico	1,056	2,595	1,250	2,858
Panama	--	--	31	84
Spain	18	47	--	--
Tunisia	106	299	45	131
United Kingdom	(2)	3	19	160
Venezuela	13	46	60	181
Other	(2)	31	(2)	62
Total	3,855	14,429	3,463	11,979

[1] Includes salt brine from Canada through Buffalo customs district for 1971, 1,000 short tons ($1,089); Seattle customs district, 28,738 short tons ($198,108).
[2] Less than ½ unit.

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
1970	45	625	3,491	12,704
1971	27	574	[1] 3,828	[1] 13,855
1972	26	535	3,437	11,444

[1] Includes salt brine from Canada through Buffalo customs district, 1,000 short tons ($1,089); Seattle customs district, 28,738 short tons ($198,108).

Table 13.—U.S. imports for consumption of salt, by customs district

(Thousand short tons and thousand dollars)

Customs district	1971 [1]		1972	
	Quantity	Value	Quantity	Value
Anchorage, Alaska	(2)	3	(2)	10
Baltimore, Md	382	1,117	261	863
Boston, Mass	332	935	213	482
Bridgeport, Conn	53	245	--	--
Buffalo, N.Y	34	149	40	191
Chicago, Ill	163	734	61	273
Cleveland, Ohio	120	561	31	151
Detroit, Mich	690	3,453	559	2,752
Duluth, Minn	40	188	43	204
Los Angeles, Calif	159	337	194	423
Milwaukee, Wis	318	1,469	174	806
New York City	137	550	142	551
Norfolk, Va	27	115	12	48
Ogdensburg, N.Y	(2)	3	4	24
Philadelphia, Pa	104	304	36	103
Portland, Maine	260	1,319	396	1,724
Portland, Oreg	161	258	320	745
Providence, R.I	140	486	28	86
St. Albans, Vt	(2)	(2)	53	3
San Juan, Puerto Rico	99	415	200	803
Savannah, Ga	200	739	223	827
Seattle, Wash	415	985	444	814
Wilmington, N.C	21	59	29	89
Other	(2)	5	(2)	7
Total	3,855	14,429	3,463	11,979

[1] Includes salt brine from Canada through Buffalo customs district for 1971, 1,000 short tons ($1,089); Seattle customs district, 28,738 short tons ($198,108).
[2] Less than ½ unit.

Table 14.—U.S. imports for consumption of salt, by use

Use	Thousand short tons	
	1971	1972
Government (highway use)	1,954	1,987
Chemical industry	96	208
Water conditioning service companies	110	144
Other	344	493
Total [1]	2,505	2,831

[1] Data may not add to totals shown because of independent rounding. Disagreement with totals in tables 1, 11, 12, and 13 is because of incomplete data on the uses of imported salt.

WORLD REVIEW

Australia.—Dampier Salt Ltd. made its first shipment of salt to Japan from a 2-million-ton-per-year solar-salt-producing facility in western Australia. The newly expanded facility jointly owned by Japanese and Australian interests initiated production in 1971. A condition of oversupply on the international salt market was blamed for the temporary halting of shipments from Lefroy Salt Co., a smaller Australian firm.[2]

Brazil.—Essentially all Brazilian salt was produced by solar evaporation of seawater in the States of Rio Grande do Norte and Rio de Janeiro. A large salt terminal was expected to be completed at Areia Bronca in Rio Grande do Norte in 1972. The terminal built on an artificial island was designed to accommodate ships ranging up to 100,000 tons. The salt was to be barged from and to the mainland.[3]

India.—Seawater continued to be the chief source of salt in India. It was recovered from coastal areas of Gujarat, Maharashtra, Kerala, Tamil Nadu, Andhra Pradesh, Orissa, and West Bengal. Salt was also produced from inland lake and subterranean brines at Sambhar Lake, Didwana, Phalodi Pachpadra, and Kuchaman.

[2] Mining Journal, London. First Salt Shipment to Japan. V. 278, No. 7133, May 5, 1972, p. 372.
[3] U.S. Embassy, Rio de Janeiro, Brazil. State Department Airgram A-128, May 24, 1972, pp. 4-5.

Table 15.—Salt: World production by country
(Thousand short tons)

Country [1]	1970	1971	1972 [p]
North America:			
Bahamas	685	1,337	890
Canada	5,359	5,542	5,535
Costa Rica	8	12	13
Dominican Republic	[r] 41	42	[e] 43
El Salvador	35	34	32
Honduras [e]	30	30	30
Martinique [e]	330	330	330
Mexico	4,578	4,806	[e] 4,850
Nicaragua	15	20	[e] 22
United States (including Puerto Rico):			
Rock salt	14,170	13,700	14,434
Other salt:			
United States	31,726	30,377	30,587
Puerto Rico	32	29	29
South America:			
Argentina	1,056	910	[e] 940
Brazil	2,013	1,628	2,400
Chile	569	469	481
Colombia:			
Rock salt	587	372	384
Other salt	254	331	743
Peru	210	[e] 210	[e] 210
Venezuela	293	[e] 290	[e] 290

See footnotes at end of table.

Table 15.—Salt: World production by country—Continued

(Thousand short tons)

Country [1]	1970	1971	1972 [p]
Europe:			
Austria:			
Rock salt	1	1	1
Other salt	542	530	551
Bulgaria	149	103	110
Czechoslovakia	235	237	240
Denmark [2]	481	147	[e] 324
France:			
Rock salt and brine salt	[r] 4,815	4,679	4,439
Marine salt	[r] 1,429	1,378	[e] 1,300
Germany:			
East	2,403	2,448	2,480
West (marketable):			
Rock salt	[r] 9,177	7,407	7,695
Marine salt and other	2,339	2,427	2,425
Greece	[r] 125	126	[e] 130
Italy:			
Rock salt and brine salt	[r] 3,181	3,740	3,704
Marine salt	1,650	1,304	793
Malta	[r] 4	3	[e] 3
Netherlands	[r] 3,165	3,491	[e] 3,530
Poland:			
Rock salt	1,349	1,346	1,333
Other salt	1,851	1,916	1,985
Portugal:			
Rock salt	214	259	304
Marine salt	228	178	[e] 180
Romania	[r] 3,155	3,250	[e] 3,250
Spain:			
Rock salt	1,241	1,311	[e] 1,320
Marine salt [3]	1,023	850	[e] 880
Switzerland	368	321	282
U.S.S.R.	13,700	13,200	[e] 13,200
United Kingdom:			
Rock salt	1,936	1,991	1,539
Other salt	8,192	[e] 8,200	[e] 8,200
Yugoslavia	[r] 281	387	297
Africa:			
Algeria	110	128	119
Angola	97	100	105
Egypt, Arab Republic of	[4] 452	464	[e] 470
Ethiopia: [5]			
Rock salt	11	11	11
Marine salt	276	309	309
Ghana	[r] 42	52	[e] 55
Kenya	[r] 43	48	31
Malagasy Republic	24	31	23
Mali	4	3	[e] 3
Mauritius	4	6	[e] 6
Morocco	63	59	50
Mozambique	[6] 32	31	[e] 31
Senegal	[r] 129	128	138
Somali Republic [e]	2	2	2
South Africa, Republic of	463	389	408
South-West Africa: Marine salt [e]	121	121	121
Sudan	58	64	66
Tanzania	46	39	[e] 44
Tunisia	331	387	364
Uganda	3	3	[e] 3
Asia:			
Afghanistan [5]	42	[e] 40	[e] 40
Bangladesh (formerly East Pakistan)	247	[e] 140	NA
Burma	173	205	232
Ceylon	71	95	174
China, People's Republic of [e]	17,600	18,200	19,800
Cyprus	8	7	6
India (including Goa)	6,160	5,986	7,165
Indonesia	69	46	55
Iran [5]	430	430	[e] 440
Iraq	[r] 56	60	[e] 60
Israel	74	88	104
Japan	1,060	1,043	757
Jordan	28	26	26
Khmer Republic	140	140	40
Korea:			
North [e]	600	600	600
Republic of	446	397	498
Kuwait	3	3	5
Laos	1	(7)	9
Lebanon [e]	41	42	44
Malaysia	NA	NA	23
Mongolia [e]	[r] 8	10	11

See footnotes at end of table.

Table 15.—Salt: World production by country—Continued

(Thousand short tons)

Country [1]	1970	1971	1972 [p]
Asia—Continued			
Pakistan:			
Rock salt	349	380	670
Other salt	244	293	258
Philippines	232	260	242
Ryukyu Islands	7	7	[e] 7
Syrian Arab Republic	51	26	[e] 33
Taiwan	590	738	483
Thailand [e]	[r] 176	176	176
Turkey	[r] 715	730	[e] 730
Vietnam:			
North [e]	165	165	165
South	[e] 132	132	44
Yemen [e]	[r] 87	96	22
Yemen, People's Democratic Republic of	97	73	[e] 70
Oceania:			
Australia	3,385	4,175	4,410
New Zealand	58	48	64
Total	[r] 161,081	158,931	162,560

[e] Estimate. [p] Preliminary. [r] Revised. NA Not available.

[1] Salt is produced in many other countries, including Cape Verde Islands and Libya, Mauritania, and Niger, but quantities are relatively insignificant or reliable data are not available.

[2] 1970 and 1971 data are sales.

[3] Includes an average annual production in the Canary Islands of 15,000 tons of marine salt.

[4] Includes small quantities of sodium sulfate and sodium salts other than sodium chloride.

[5] Year beginning March 21, of year stated.

[6] Marine salt only.

[7] Less than ½ unit.

Rock salt was produced at Guma, Maudi District, Hunachal Pradesh. Reserves of rock salt in the Maudi District were estimated at 7.6 million tons.[4]

Italy.—The Trapani Salt Flats, the site of a solar salt industry for more than 2,000 years, will be closed according to an announcement by the Sicilian Government. Outdated, hand-labor production methods unchanged from the Middle Ages were cited as an important factor in the closing. The fact that the land was more valuable as construction sites for tourists' cottages was also considered.[5]

Netherlands Antilles.—The first shipment of salt was made from the new solar salt facility of International Salt Co. at Bonaire on the Island of Aruba. The new salt facility was reported to have a potential production capacity of 400,000 tons per year.[6]

TECHNOLOGY

The increased use of road salt for "bare pavements" in the snow belt caused concern among ecologists, conservationists, and others involved with problems of environmental pollution. Numerous studies have been made of the environmental effects of the use of road salt in specific localities. One of these studies made in the east-central section of Massachusetts indicated that the continued use of road salt might increase the average steady-state NaCl concentration in ground water by 160 milligrams per liter (parts per million).[7] Drinking water standards ranging from 250 to 500 parts per million have been recommended. Although the concentration of salt that may eventually occur in the ground water in eastern Massachusetts may not be harmful to the general population, persons on special low-sodium diets may be adversely affected. About 22 tons per lane-mile per year were used to salt the roads in the area studied. The Salt Institute, a national association of salt producers, recommended "sensible restraint" in the use of deicing salt.

Production of salt from seawater by electrodialysis rather than by solar evaporation was expected to become a reality in Japan with the installation of a 150,000 ton-per-

[4] U.S. Embassy, New Delhi, India. State Department Airgram A-276, June 23, 1972, p. 79.

[5] U.S. Embassy, Rome, Italy. State Department Airgram A-8, Aug. 25, 1972, pp. 1–2.

[6] Jacoby, C. H. Salt. Min. Eng., v. 25, No. 1, January 1973, pp. 46–47.

[7] Huling, E. E., and Hollocher, T. C. Groundwater Contamination by Road Salt: Steady-State Concentrations in East Central Mass. Science, v. 176, No. 4032, Apr. 21, 1972, pp. 288–290.

year plant at Okayama.[8] The operating labor costs of the new plant were one-sixth that for a solar plant, and the 16 electrodialyzers occupied a fraction of the space that would be required by solar evaporating ponds for equivalent salt output. A second plant was expected to open at Nagasaki. The Nagasaki plant was to produce chlorine, caustic soda, and hydrogen as well as salt.

In the electrodialysis units, semipermeable membranes under the influence of an electrical potential separate the charged ionic particles from seawater producing a brine concentrate from which the salt is crystallized.

Rock salt resources of Oklahoma at depths ranging from 30 to 3,000 feet were estimated at 20 trillion tons in a report by an Oklahoma geologist.[9] Examination of many gas and oil well logs throughout the State provided information on salt deposits which indicated that they were much larger than previously estimated. Three principal Permian salt sequences each 100 to 1,000 feet thick underlie the western half of the State. Individual salt beds are typically 5 to 30 feet thick and are interbedded with reddish-brown shale and possibly anhydrite and gypsum. In addition to the rock salt reserves, five natural salt springs in western Oklahoma produce an estimated total of 6,300 tons of salt per day. The outflow of the springs produce a barren area called a salt plain. The only salt production in Oklahoma is by solar evaporation of brine on these plains. Production costs of salt either as brine or crystallized salt were said to be potentially lower than the average for the nation and could make Oklahoma competitive with the larger salt producing States.

A novel system for recovering geothermal energy was suggested in a patented process in which a "heat well" would be created at great depth in a salt dome or other deep-seated salt formation using available drilling equipment and techniques.[10] Utilizing the high heat conductivity of solid salt formations the heat energy of the earth would be transmitted to the "heat well" where it would be removed and utilized by a suitable fluid circulating through a heat exchanger. The energy collected could be utilized in the mining and purification of salt by recrystallization or for other purposes.

---

8 Chemical Engineering. Electrodialysis Is Offering Advantages Over Solar Basins for Salt Production. V. 79, No. 3, Feb. 7, 1972, p. 22.

9 Johnson, K. S. Gypsum and Salt Resources in Oklahoma. Ind. Miner., No. 62, November 1972, pp. 33–39.

10 Jacoby, C. H. (assigned to International Salt Co.). Salt Solution Mining and Geothermal Heat Utilization System. U.S. Pat. 3,676,078, July 11, 1972, 6 pp.

Sand and Gravel

By Walter Pajalich [1]

Sand and gravel production decreased about 1% to 913 million short tons. The value of production increased about 4%. Output from commercial operations was 86% of the total output, while Government-and-contractor production was 14%. The production of sand and gravel in the Nation's leading State, California, increased from 115 million short tons in 1971 to 117 million short tons in 1972.

DOMESTIC PRODUCTION

California, with 117 million tons, ranked first in sand and gravel output and produced about twice as much as second-ranked Michigan. Other States producing substantial quantities of sand and gravel in descending order of production were Ohio, Illinois, Minnesota, Wisconsin, and Texas. Combined production from the seven leading States was 369 million tons, about 40% of the total U.S. output. The value of sand and gravel produced in these seven States was $471 million, 39% of the Nation's total. The number of commercial operations continued to decline from 5,738 in 1971 to 5,384 in 1972.

Factors, which have added to the consumer cost of sand and gravel, included increased labor costs, growing land values, cost of land rehabilitation, longer haulage distances, which increase transportation cost, and the need to produce from lower quality deposits as better ones become depleted or covered by urban expansion.

There were 4,286 commercial operations with production under 200,000 tons per year. These operations accounted for 30% of the total U.S. production. There were 751 operations with production between 200,000 and 500,000 tons, and they accounted for 30% of production. The remaining 347 operations with production over 500,000 tons, accounted for 40% of production.

The use of larger operating units, more efficient portable and semiportable plants, versatility of plant capacity, and greater awareness of pollution control and land rehabilitation were the keynote of progress in 1972.

Anchorage Sand & Gravel Co.'s new plant in Alaska, has a 10-year supply of sand and gravel from several pits in the area. The 400- to 500-ton-per-hour plant has the versatility of making marketable products from a variety of sources. The plant is highly automated with a central console control for the entire operation.[2]

Ohio Gravel Co., Division of Dravo Corp. opened a new 900-ton-per-hour plant at Newton, Ohio. The operation is automated and controlled from a central console. It is monitored by a closed-circuit TV system and coordinated through use of a UHF radio communications system. The stockpile storage area will hold up to 200,000 tons of material. The 75-acre mining property is under lease and is estimated to contain about 5.5 million tons of sand and gravel reserves. The property is on the perimeter of land owned by Dravo Corp. Sand and gravel mined on the property is hauled to the plant on a 2½-mile off-highway road.[3]

Consolidated Rock Co. began working a sand and gravel property at Irwindale, Calif. The deposit is located on the alluvial fan at the mouth of the San Gabrial River. The plant is automated and has a 2,400-ton-per-hour capacity.[4]

---

[1] Mining Engineer, Division of Nonmetallic Minerals—Mineral Supply.

[2] Pit & Quarry. New Alaskan Gravel Plant Uses Modern Methods—Equipment. V. 64, No. 12, June 1972, pp. 81–82.

[3] Levine, Sidney. Ohio Gravel Replaces Multi-Unit Complex With 900-tph Plant. Rock Products, v. 75, No. 9, September 1972, pp. 74–77.

[4] California Geology. A Publication of the California Division of Mines and Geology. V. 25, No. 10, October 1972, pp. 233–234.

Table 1.—Sand and gravel sold or used by producers in the United States,[1] by class of operation and use

(Thousand short tons and thousand dollars)

Class of operation and use	1971		1972 [2]	
	Quantity	Value	Quantity	Value
Construction:				
Building:				
Sand	177,664	225,278	187,794	248,238
Gravel	145,202	218,046	153,254	237,914
Paving:				
Sand	134,311	152,747	131,402	157,427
Gravel	311,467	357,278	280,159	335,201
Fill:				
Sand	46,647	26,904	48,567	32,626
Gravel	35,093	23,382	43,458	29,913
Railroad ballast:				
Sand	1,869	2,224	1,045	1,186
Gravel	2,347	2,570	2,229	2,332
Other:				
Sand	14,103	18,220	9,575	10,290
Gravel	14,590	18,271	12,880	14,247
Total construction [3]	883,291	1,044,916	870,363	1,069,374
Industrial sand:				
Unground:				
Glass	9,683	36,445	10,828	41,259
Molding	7,302	21,763	7,522	24,827
Grinding and polishing	243	688	262	731
Blast sand	892	5,361	1,072	6,278
Fire or furnace	257	680	703	2,243
Engine	708	1,685	601	1,387
Filtration	200	612	234	1,176
Oil hydrofrac	302	1,883	282	1,071
Other	4,664	9,365	3,514	11,868
Total [3]	24,248	78,483	25,018	90,840
Ground sand [4]	1,911	12,893	4,512	21,546
Total industrial [3]	26,161	91,371	29,530	112,386
Miscellaneous gravel	10,142	12,682	13,482	17,759
Grand total [3]	919,593	1,148,969	913,375	1,199,520
Commercial:				
Sand	362,607	480,713	378,512	537,830
Gravel	409,773	527,032	407,276	550,121
Government-and-contractor: [5]				
Sand	38,151	36,037	29,402	24,324
Gravel	109,063	105,194	98,185	87,245

[1] Excludes American Samoa and Puerto Rico.
[2] Data not directly comparable with previous years because of changes in industry coverage.
[3] Data may not add to totals shown because of independent rounding.
[4] See table 10 for use breakdown.
[5] Approximate figures for operations by States, counties, municipalities, and other Government agencies under lease.

Victory Sand and Concrete, Inc.'s, new 250-ton-per-hour aggregate plant started operating in June. Sand and gravel is dredged from the Kansas River at Topeka, Kan. Although most of the production will go to the related company May-Ransom-Sheetz, Contractors, Inc., some of the material will be available for commercial sale. The plant has liquid-solids separation equipment, which includes screening units, dewatering screws, and an automatic sand-classifying tank.[5]

A new sand dredging operation near Clermont, Fla., has been started by WSW Mining Co., Inc. The plant has a 550-ton-per-hour capacity. Reserves are estimated at 35 million tons.[6]

The new 385-ton-per-hour sand plant of Brown Brothers Sand Co., Howard, Ga., is supplying sand for concrete, mortar, and special uses as far as 200 miles away. The plant consists of a dredge, scalping screen, washing bins, surge tank, two sand pumps, and four hydrocyclones.[7]

Owens-Illinois sand processing plant in Trampas Canyon east of San Juan Capistrano, Calif., went into production. Products are glass sand, with both amber and flint grades produced.

[5] Levine, Sidney. Automatic Sand Classifier Processes Aggregate. Rock Products, v. 75, No. 9, September 1972, pp. 64–66.
[6] Pit & Quarry. V. 65, No. 2, August 1972, p. 20.
[7] Trauffer, Walter E. A New 386-tph Georgia Sand Plant. Pit & Quarry, v. 65, No. 4, October 1972, pp. 117–120.

The You Bet White Co. is mining the high-grade (99.6% SiO_2) Bear River stream gravels below Rollins Reservoir east of Colfax, Calif. The gravel is crushed to minus 350 mesh and sold in the Sacramento area for use as an abrasive in the manufacture of scouring powder. Part of the production is shipped by rail to Oregon for use in silicon carbide manufacture.[8]

About 400 billion tons of commercially significant sand occurs in the upper 10 feet of the ocean floor off the northeastern coast of the United States. These large deposits have immediate useful potential for this part of the country and can also supply some of the eastern Provinces of Canada.[9]

[8] Work cited in footnote 4.

[9] Manheim, Frank T. Mineral Resources off the Northeastern Coast of the United States. U.S. Geol. Survey Cir. 669, 1972, 27 pp.

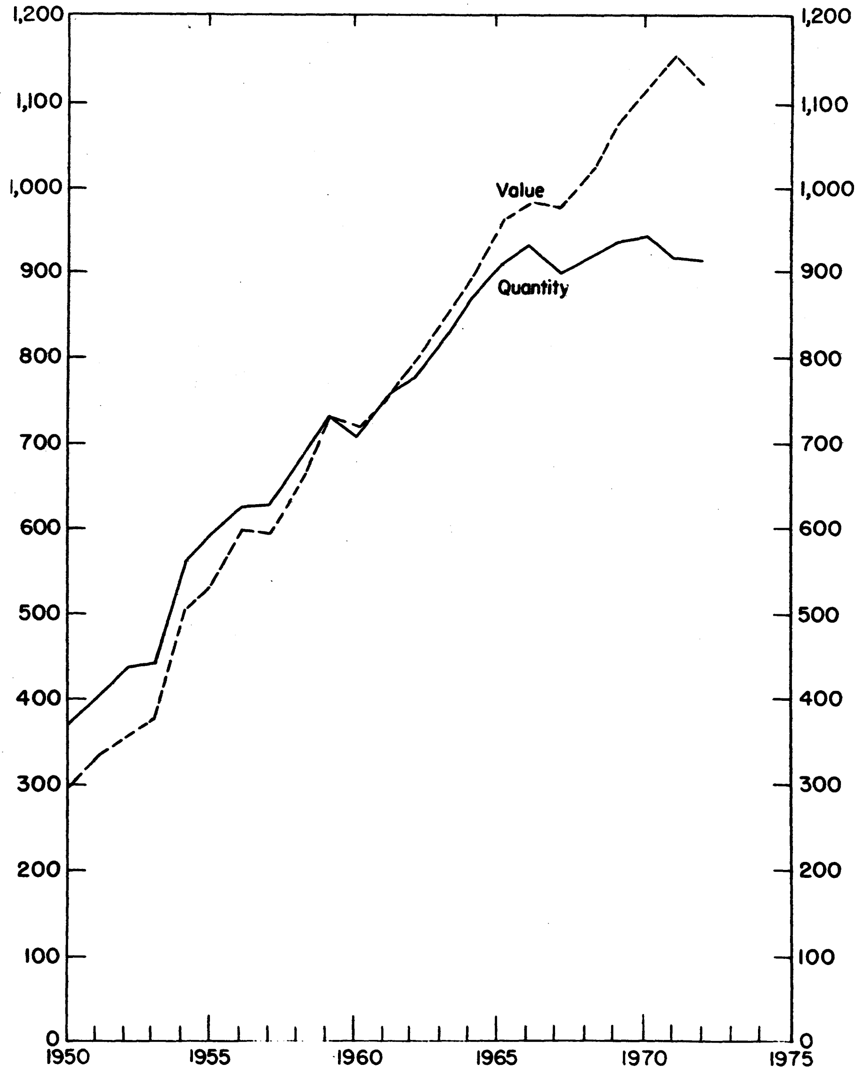

Figure 1.—Production and value of sand and gravel in the United States.

CONSUMPTION AND USES

In 1972, U.S. consumption of sand and gravel amounted to 913 million tons valued at $1.2 billion. The construction industry, the prime user of sand and gravel, consumed 95% of the tonnage. This was 89% of the value of the sand and gravel output in 1972. Of the amount of sand and gravel consumed by the construction industry, 47% went into paving, 39% into building, about 11% into fill, and 3% into other uses. The principal consumers of higher priced industrial sand were the glass and foundry industries.

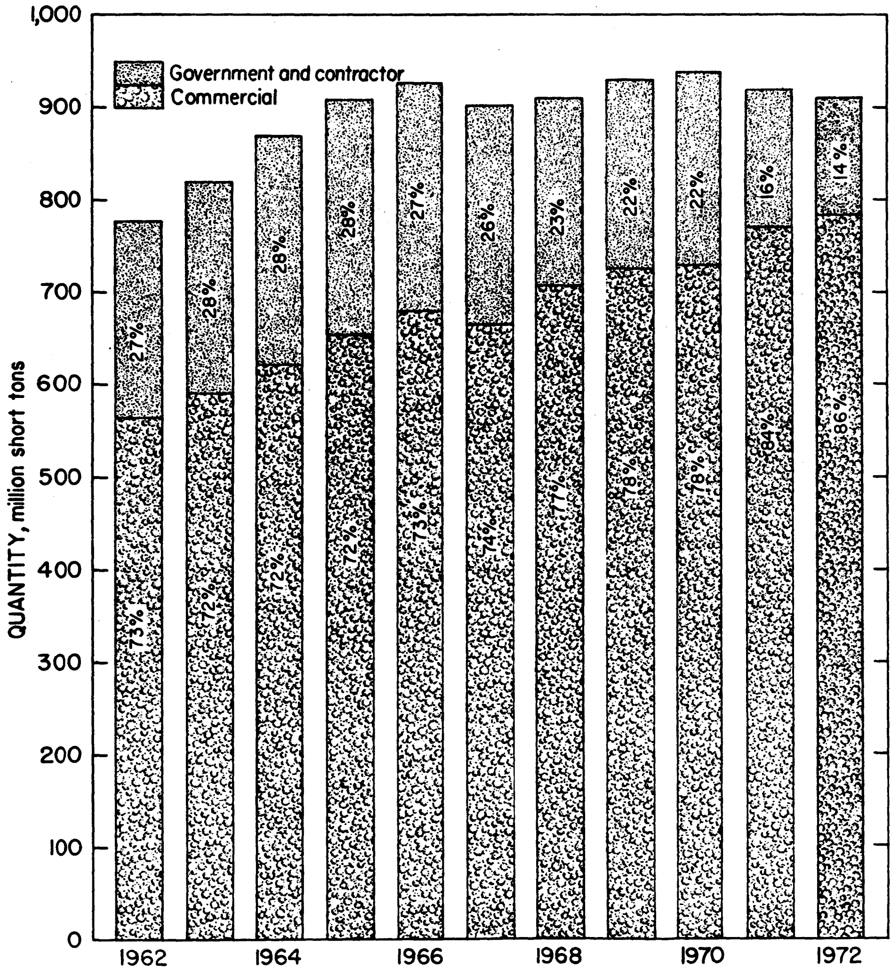

Figure 2.—Sand and gravel sold or used in the United States.

PRICES

Representative carload-lot prices of sand in 19 cities at the end of 1972 ranged from $1.05 per ton in Detroit to $5.40 per ton in Pittsburgh, according to the Engineering News-Record.[10] The average of the sand prices reported was $3.14 per ton, compared with $3.23 per ton in 1971. Prices for either 3/4- or 1 1/2-inch gravel ranged from $1.60 per ton in Birmingham to $7 per ton in New Orleans. The average of the 3/4-inch gravel prices reported for 20 cities was $3.80 per ton, compared with $3.67 per ton in 1971. For 1 1/2-inch gravel, the average for 18 cities was $3.74 per ton compared with $3.48 per ton in 1971.

The average price of sand in Montreal and Toronto, Canada, at the end of 1972 was $2.30 per ton; 3/4-inch gravel was $2.43 per ton, and 1 1/2-inch gravel was $2.35 per ton.

Based on the Bureau of Mines canvass, the average value of sand and gravel sold or used by producers, f.o.b. plant, was $1.31 per ton; the comparable value in 1971 was $1.25 per ton.

FOREIGN TRADE

Canada received 79% of U.S. exports of construction sand, the Bahamas received 20%, and Venezuela received less than 1%. The remainder went to 20 different countries. Exports of construction sand totaled 419,647 short tons, valued at $801,236. Gravel exports totaled 352,560 short tons valued at $462,514. Total exports of common sand and gravel were 772,207 short tons, valued at $1,263,750. Canada received 78% of U.S. exports of common sand and gravel, the Bahamas received 12%, and Mexico received 8%. Of U.S. exports of industrial sand, which amounted to 1,048,775 short tons valued at $5,944,231, Canada received 74%, Mexico 13%, and Colombia about 4%. The remainder went to 59 different countries.

Most of the crude sand and gravel imported in 1971 was from Canada. Almost all of the imported glass sand was from Australia.

WORLD REVIEW

Belgium.—About 90% of Belgian sand and gravel was extracted in the Limburg Province along the River Meuse. The depths of the deposits vary between 30 and 60 feet. Additional sand and gravel was dredged from the River Meuse, where the ratio of gravel to sand was 4:1. In 1972, Belgium produced about 15 million tons of sand and gravel.

Canada.—It has been estimated that aggregate consumption in some Canadian urban centers was about 5.4 tons per person. Consumption is expected to reach 18 tons per person by 1980. Construction activity, particularly heavy or engineering construction, regulates the production of sand and gravel in Canada. The upward trend in production peaked in 1966 to 1967 with the large demand for construction materials related to Expo '67. In the post-Expo years demand decreased and has stabilized to a more normal annual increment of increase. Total sand and gravel production for 1971 was estimated at 201 million tons valued at $134 million. The largest production of 85 million tons was in Ontario province followed by 37 million in Quebec.[11]

A recent survey by the Aggregate Producers Association of Ontario indicated that transportation costs to the consumer represented approximately 60% of the f.o.b. pit selling price of the product. For each mile sand and gravel products are hauled an additional 5 cents per ton was required. The f.o.b. pit selling price ranges from 50 cents to $1.25 per ton. Trucks move 95% of the total production. When the product was moved 5 miles from the source, the transportation cost represented approximately 30% of the total market value, and 40% when the distance was more than 20 miles.[12]

France.—Sand and gravel is found throughout France. Main areas of concen-

[10] Engineering News-Record, McGraw-Hill Construction Weekly, Dec. 7, 1972, pp. 50–51.
[11] Stonehouse, D. H. Sand and Gravel. Canadian Mineral Yearbook Preprint, No. 38, 1971.
[12] Yundt, Sheralyn E. Sand and Gravel Transportation in Ontario. Cement Lime and Gravel, v. 47, No. 9, September 1972, pp. 204–205.

tration are in the large valleys of the Seine, Rhone, Loire, and Rhine Rivers. There were about 1,500 producers of sand and gravel in France, many of whom are located in the Seine Valley. The 150 largest producers provide 60% of the national production. The average price f.o.b. plant ranges from $1 to $1.25 per ton of sand and gravel.

Laws that governed the sand and gravel industry dated back to the time of Napoleon I, however in 1970 these laws were changed. Authorization to mine sand and gravel now must include detailed information about the deposit, method of operation, and land restoration.

Although the French Continental Shelf is known to contain large sand and gravel reserves there is little dredging of these deposits. Only 1% of the country's consumption of about 190 million tons of sand and gravel comes from dredging operations.[13]

United Kingdom.—Three new plants have gone into production for Blue Circle Aggregates, Ltd. Located at Elford near Tamworth Staffs, Huntley Wood near Cheadle Staffs, and Repton near Burton on Trent Staffs, these plants will serve the Midland market. They have been designed with up-to-date control, instrumentation, and closed-circuit TV, which enables them to operate with the minimum of personnel. Each plant is capable of producing 10,000 tons of aggregates per week.[14]

The new Parker sand and gravel plant at Chard went into operation after the 40-year-old plant at the site was dismantled. The firm of J. R. Pratt and Son, Ltd., owners of the old and new plants have been in business for over 50 years. The new plant was designed to produce 100 tons per hour.[15]

Near the village of Thurlby Butterley, Blue Circle Aggregates, Ltd., has started dredging a new sand and gravel deposit. A floating pontoon with a 10-inch pump driven by a 370-horsepower diesel engine delivers the material directly to the plant through a floating pipeline. Operating capacity is 120 tons per hour.[16]

In the United Kingdom, production of sand and gravel is usually exceeded only by that of coal. Sand and gravel production in 1972 was about 130 million tons, most of which came from land-based operations. Offshore production began to increase in the 1960's as the demand for materials increased and dredged materials became more competitive. There are at least 15 companies operating between 60 and 70 sand and gravel dredging vessels of varying capacities. About 10% or 13 million tons of sand and gravel was produced by dredging. About one-quarter of the dredged material was exported to the Continent.

Until 1966, production of sand and gravel was greater than crushed stone. In 1972 crushed stone production was about 140 million tons. At present rates of growth, limestone alone is expected to exceed the production of natural sand and gravel by 1974. Much of the future of sand and gravel production will depend on present land restoration methods that will almost certainly govern future release of land for sand and gravel extraction.

TECHNOLOGY

Airborne resistivity mapping known as E-Phase has been developed by Barringer Research, Inc., for mapping sand and gravel deposits. The systems sensing method measures resistivity of the upper 10 to 150 feet of surface. Resistivity airborne surveys allow complete and quick coverage of land that may not be traversed on the ground because of terrain problems or urbanization.[17]

At the Plastic Disposal Research Institute, Funabashi, Japan, a system of converting plastic waste into pavement material was developed. The plastic waste is crushed into small pieces, melted, and the poisonous gas removed. The pieces are then pelletized and passed through a water tank and turned into artificial gravel.[18]

---

[13] Bourgeois, R. The Sand and Gravel Industry in France. Cement Lime and Gravel, v. 47, No. 9, September 1972, pp. 197–199.

[14] Rock Products. Three U. K. Aggregate Plants Go Onstream. V. 75, No. 6, June 1972, pp. 65–68.

[15] Cement Lime and Gravel. New Sand and Gravel Plant. V. 47, No. 5, May 1972, pp. 106–110.

[16] Cement Lime and Gravel. Dredging a Trent Valley Gravel Deposit. V. 47, No. 1, November 1972, pp. 247–250.

[17] Pit & Quarry. Sand and Gravel Deposits Mapped by Aerial Technique. V. 65, No. 1, July 1972, pp. 79–80.

[18] The Evening Star and Daily News, Washington, D.C. Tuesday, Nov. 14, 1972, p. A-3.

Dramatic upgrading of low-grade sand and gravel has been reported by Young's Sand and Gravel Co., Loudonville, Ohio. Designated as the Rib-O-Matic, the new process uses a horizontal circular plate that supports a bed of material to which crushing and kneading forces are applied by six sets of rubber wheels or rollers. The crushing effect between the wheels and bed of material crushes, then pulverizes, the unsound aggregate while scouring and cleaning the sound aggregate.[19]

Williamstown, Mass., became the first town in New England to pave a road with a mixture of reclaimed rubber and asphalt. The 400-foot section of road was paved with "Ramflex," manufactured by U.S. Rubber Reclaiming Co. About 30 reclaimed tires went into the 1½ inches of asphalt mixture laid down on this stretch of road.

The Pennsylvania Department of Transportation completed 1.8 miles of test paving on high-speed U.S. Route 322 between Harrisburg and Hershey. The material used was a German-originated mastic asphaltic compound, Gussaphalt, which has been successfully used on more than 1,500 miles of prime Autobahn roads 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 the use of native lake asphalt, which holds colloidal material in suspension, a property not present in petroleum asphalt. The asphaltic mixture is combined with limestone, sand, and 1-B stone at the originating plant and then transported to the construction site at a maintained temperature of 410 to 450 degrees fahrenheit. A crimper-spiked roller makes a waffle-like pattern in the surface of the finished pavement, which adds to its skid resistance.

New dredge designs have been developed for the hydraulic and bucket-line ladder dredges enabling them to operate in greater water depths than before. Also economical construction of larger dredges is now possible. Some of the new features allow hydraulic ladder dredges to dredge 300 feet or more and bucket-line ladder dredges to dig 200 feet or more below the water level surface. The improved design allows for operation under sea wave and swell conditions, lower ratio dredge displacement weight to capacity, and increased dredge efficiency and production. Design changes include the use of a multiple section articulated ladder, which may comprise two or more ladder sections, and a new principle of compensating for sea and wave swell conditions.

Dust control received considerable attention last year. In most sand and gravel operations, dust suppression is a problem. Suppression can be achieved by confinement of the dust with a curtain of moisture, direct wetting of the dust, or the combining of dust particles with each other by the use of a liquid spray, thus making the dust particles too heavy to become airborne or to remain airborne. Another system of control is the collection of dust or fines. Chemicals are often added to water to increase its wetting capability.

The Conrock Co. of California has embarked on a full scale dust control program for their production facilities, stockpiles, and roads. The program uses the dust control chemical Coherex in a 1 to 10 part water ratio.[20]

The Hills Materials Co., Rapid City, S. Dak., uses a cyclone dust collector. This resulted in a bag collection of fines that are sold as mineral filler.[21]

The Construction Aggregates Rail Shippers (CARS) Conference study on aggregate shipments by rail, done by A. T. Kearney & Co. Inc., issued its first report. The study found some of the reasons why it is generally unprofitable to move aggregates by rail and made a series of recommendations to aggregate producers and receivers on how they can help the railroads alleviate some of the problems. Most of the recommendations are directed at reducing costs of rail transportation. CARS was organized in 1969 through the sponsorship of the National Crushed Stone Assoc., National Limestone Institute, Na-

[19] Roads and Streets Highway/Heavy Construction. New Weapon in Attack on Marginal Aggregates. V. 115, No. 7, July 1972, pp. 27–28.

[20] Pit & Quarry. Conrock Controls Fugitive Dust Efficiently and Economically. V. 65, No. 3, September 1972, p. 27.

[21] Roads & Streets Highway/Heavy Construction. Asphalt Plant Solves Dust Problem, Makes Valuable By-product. V. 115, No. 7, July 1972, pp. 97–101.

tional Sand and Gravel Assoc., and the National Slag Assoc.[22]

The Soviets have developed a liqiud sand process for ingot mold and steel castings. The mixture can be poured readily into core boxes or molds in which it hardens without any external action such as gassing or drying. Liquid sands are created by adding small amounts of surface acting agents to insure intensive foam-formation as sand and bonding material are mixed together. The mixing changes the plastic state of the material into a state whereby the mixture behaves like a liquid. Self-setting is due to the addition of some solidifying agent that reacts with the bonding material. A variety of sand mixes have been developed. One widely used in steel and iron foundry work is silica sand, with sodium silicate as the bonding material, alkilaril-sulfonates (mostly petroleum sulfoacids) as the surface active mixture, and ferro-chromium production slag containing dicalcium silicate as the setting agent.[23]

[22] CARS Report, V. I and II. Prepared by A. T. Kearney & Co., for The Construction Aggregates Rail Shippers Conf., 1415 Elliot Place, NW., Washington, D.C. 20007.

[23] Foundry. Preparing Liquid Sand Mixes. V. 100, No. 9, September 1972, pp. 82–84.

Table 2.—Sand and gravel sold or used by producers in the United States [1]

(Thousand short tons and thousand dollars)

Year	Sand		Gravel		Total [2]	
	Quantity	Value	Quantity	Value	Quantity	Value
1968	369,221	433,088	548,247	587,019	917,468	1,020,107
1969	380,878	465,843	556,291	603,826	937,169	1,069,667
1970	383,378	484,722	560,563	630,985	943,941	1,115,705
1971	400,759	516,749	518,833	632,226	919,593	1,148,969
1972 [3]	407,914	562,154	505,461	637,366	913,375	1,199,520

[1] Excludes American Samoa and Puerto Rico.
[2] Data may not add to totals shown because of independent rounding.
[3] No sand and gravel production in American Samoa in 1972. Data not directly comparable with previous years because of changes in industry coverage.

Table 3.—Sand and gravel sold or used by producers in the United States, by State and class of operation

(Thousand short tons and thousand dollars)

State	1971						1972					
	Commercial		Government-and-contractor		Total [1]		Commercial		Government-and-contractor		Total [1]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Alabama	6,655	7,466	19	48	6,674	7,513	6,352	8,530	--	--	6,352	8,530
Alaska	3,618	4,321	19,999	28,484	23,617	32,806	4,252	4,183	9,936	11,031	14,187	15,214
Arizona	17,210	21,766	2,581	2,624	19,791	24,391	22,619	29,131	2,223	3,290	24,842	32,420
Arkansas	9,850	13,993	1,779	1,611	11,630	15,603	10,004	15,045	1,571	1,514	11,574	16,558
California	104,220	142,279	11,248	15,404	115,468	157,683	104,419	154,544	12,869	8,075	117,288	162,619
Colorado	19,145	24,873	7,854	5,283	27,000	30,155	22,211	30,285	6,106	4,346	28,318	34,631
Connecticut	6,566	9,815	355	447	6,921	10,262	5,924	9,560	839	1,710	6,763	11,270
Delaware	2,205	2,231	--	--	2,205	2,231	2,257	2,660	--	--	2,257	2,660
Florida	22,915	18,666	314	169	23,228	18,836	20,707	14,979	45	45	20,752	15,025
Georgia	3,697	5,310	--	--	3,697	5,310	3,816	4,729	--	--	3,816	4,729
Hawaii	836	1,967	--	--	836	1,967	584	1,890	25	3	609	1,893
Idaho	4,404	6,421	6,876	5,016	11,279	11,437	3,825	5,896	3,871	4,398	7,696	10,294
Illinois	44,827	58,907	536	490	45,364	59,397	39,533	61,328	397	368	39,929	61,696
Indiana	23,689	28,326	1,293	767	24,982	29,094	26,652	32,348	1,326	943	27,978	33,290
Iowa	16,954	19,216	1,325	1,314	18,279	20,530	15,772	19,064	1,335	1,076	17,107	20,140
Kansas	10,056	9,991	1,807	1,361	11,862	11,351	9,265	9,588	2,326	1,333	11,591	10,920
Kentucky	8,031	11,023	171	37	8,202	11,061	8,321	11,919	163	48	8,485	11,967
Louisiana	18,823	23,861	405	631	19,228	24,492	18,538	26,255	383	740	18,920	26,996
Maine	3,865	4,210	4,427	1,671	8,292	5,881	4,126	4,394	7,692	3,140	11,818	7,535
Maryland	12,730	23,185	112	16	12,842	23,201	12,426	26,517	167	40	12,594	26,557
Massachusetts	14,938	20,872	2,404	2,186	17,343	23,058	16,568	23,782	2,315	1,873	18,883	25,655
Michigan	51,356	59,047	5,257	3,851	56,613	62,898	54,683	63,646	4,784	1,799	59,467	65,445
Minnesota	35,936	33,113	8,989	4,532	44,916	37,645	30,451	29,972	6,341	3,482	36,792	33,454
Mississippi	11,234	13,413	55	114	11,289	13,526	13,295	15,867	124	266	13,419	16,133
Missouri	10,263	15,031	64	78	10,327	15,109	10,068	14,779	14	27	10,082	14,806
Montana	1,909	2,244	13,872	22,963	15,781	25,207	2,138	3,022	7,977	14,126	10,116	17,149
Nebraska	12,575	13,218	649	408	13,224	13,626	12,317	13,376	1,403	1,688	13,720	15,063
Nevada	6,508	10,191	2,871	2,034	9,379	12,225	7,722	10,691	2,359	1,945	10,081	12,636
New Hampshire	6,174	6,132	2,230	644	8,404	6,777	4,815	5,951	1,204	305	6,020	6,256
New Jersey	18,505	38,275	7	4	18,511	38,279	17,666	38,010	13	11	17,679	38,020
New Mexico	7,573	6,374	1,296	1,601	8,869	7,975	5,609	6,894	1,991	1,659	7,600	8,553
New York	21,284	27,678	1,937	650	23,221	28,328	24,594	36,321	2,128	631	26,722	36,952
North Carolina	10,191	13,306	4,049	1,385	14,240	14,690	10,072	13,203	3,413	1,413	13,485	14,615
North Dakota	6,053	5,251	2,144	959	8,196	6,210	4,708	4,678	1,974	1,078	6,681	5,757
Ohio	40,539	53,790	259	254	40,797	54,044	43,276	59,702	229	230	43,506	59,932
Oklahoma	4,864	7,375	849	885	5,713	8,259	7,306	10,181	595	957	7,901	11,138
Oregon	16,875	23,978	3,355	4,729	20,230	28,707	20,736	30,462	3,753	4,519	24,489	34,981
Pennsylvania	19,668	36,162	--	--	19,668	36,162	18,757	36,804	--	--	18,757	36,804
Rhode Island	2,252	3,052	--	--	2,252	3,052	2,008	3,265	71	71	2,079	3,336
South Carolina	6,488	9,119	--	--	6,488	9,119	7,916	12,121	--	--	7,916	12,121
South Dakota	8,117	8,218	8,610	10,174	16,727	18,392	5,772	6,423	6,976	8,369	12,748	14,793
Tennessee	7,242	11,357	776	488	8,018	11,845	10,441	15,157	398	172	10,839	15,328
Texas	29,607	48,831	3,181	2,983	32,788	51,814	33,036	54,658	2,115	1,670	35,151	56,328

See footnotes at end of table.

Table 3.—Sand and gravel sold or used by producers in the United States, by State and class of operation—Continued

(Thousand short tons and thousand dollars)

State	1971						1972					
	Commercial		Government-and-contractor		Total [1]		Commercial		Government-and-contractor		Total [1]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Utah	8,451	8,823	2,054	1,367	10,505	10,190	11,652	13,989	2,967	3,082	14,619	17,071
Vermont	2,993	3,249	768	268	3,761	3,518	2,477	3,014	825	199	3,302	3,214
Virginia	12,776	20,198	20	3	12,796	20,201	13,976	21,648	109	48	14,085	21,696
Washington	19,648	24,260	3,054	2,399	22,702	26,658	18,264	23,440	4,801	2,629	23,065	26,069
West Virginia	7,107	16,756	--	--	7,107	16,756	5,765	15,030	(2)	1	5,765	15,031
Wisconsin	26,703	26,595	11,857	6,153	38,561	32,748	24,418	24,880	12,012	6,443	36,430	31,324
Wyoming	4,307	4,006	5,513	4,744	9,820	8,750	3,678	4,142	5,419	10,774	9,098	14,916
Total [2]	772,382	1,007,741	147,212	141,229	919,593	1,148,969	785,788	1,087,951	127,587	111,569	913,375	1,199,520
American Samoa [3]	--	--	32	25	32	25	--	--	--	--	--	--
Puerto Rico [e]	[r] 12,768	[r] 34,196	[r] 230	[r] 784	[r] 12,998	[r] 34,980	[p] 7,246	[p] 20,446	[p] 232	[p] 792	[p] 7,478	[p] 21,237

[e] Estimate. [p] Preliminary. [r] Revised.

[1] Data may not add to totals shown because of independent rounding. Data not directly comparable with previous years because of changes in industry coverage.

[2] Less than ½ unit.

[3] There was no sand and gravel production in American Samoa in 1972.

Table 4.—Sand and gravel sold or used by producers in the United States in 1972, by State, use, and class of operation [1]

(Thousand short tons and thousand dollars)

State	Sand, construction							
	Building				Paving			
	Commerical		Government-and-contractor		Commercial		Government-and-contractor	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Alabama	1,796	1,937	--	--	814	1,299	--	--
Alaska	162	294	1	(2)	W	W	2,865	2,827
Arizona	4,159	6,880	19	26	1,632	2,100	564	752
Arkansas	2,641	4,359	--	--	1,808	2,096	688	554
California	23,370	34,737	36	37	17,507	23,313	1,094	1,563
Colorado	3,832	5,732	55	116	882	1,351	316	265
Connecticut	1,365	2,308	--	--	1,596	2,717	27	29
Delaware	330	553	--	--	W	W	--	--
Florida	7,386	7,488	--	--	3,253	3,148	--	--
Georgia	3,062	2,942	--	--	W	W	--	--
Hawaii	373	1,175	--	--	W	W	--	--
Idaho	554	1,064	1	2	182	164	373	761
Illinois	6,585	7,753	(2)	(2)	7,819	8,998	42	44
Indiana	4,673	5,144	--	--	6,064	6,853	133	130
Iowa	3,023	3,704	(2)	(2)	2,787	3,675	225	262
Kansas	3,888	4,158	--	--	2,652	2,781	797	435
Kentucky	3,222	4,912	--	--	2,129	2,954	24	24
Louisiana	5,319	6,756	--	--	2,254	2,612	201	371
Maine	439	573	--	--	830	782	1,442	558
Maryland	5,231	10,510	--	--	1,343	2,907	11	2
Massachusetts	3,877	5,813	--	--	2,181	2,756	677	406
Michigan	7,862	7,571	4	1	8,772	8,960	700	213
Minnesota	5,814	5,512	3	1	2,746	2,435	311	270
Mississippi	2,627	2,989	56	86	2,003	2,137	--	--
Missouri	3,759	3,989	--	--	1,597	1,707	(2)	(2)
Montana	302	555	--	--	115	215	165	677
Nebraska	3,599	3,482	(2)	(2)	965	1,165	269	307
Nevada	945	1,454	--	--	174	218	704	759
New Hampshire	1,695	2,130	--	--	383	407	189	59
New Jersey	4,832	7,425	--	--	3,440	4,358	--	--
New Mexico	1,495	2,124	--	--	323	325	67	99
New York	8,795	13,573	--	--	2,997	4,181	30	8
North Carolina	4,546	4,878	--	--	2,065	1,722	2,035	892
North Dakota	470	757	--	--	82	85	79	31
Ohio	7,158	9,519	9	13	8,765	11,080	92	101
Oklahoma	3,078	3,572	34	478	1,935	2,094	220	46
Oregon	3,030	4,514	--	--	1,914	3,307	10	15
Pennsylvania	5,164	9,265	--	--	2,441	4,649	--	--
Rhode Island	338	506	--	--	553	W	56	56
South Carolina	4,213	3,366	--	--	716	489	--	--
South Dakota	604	765	--	--	382	399	104	124
Tennessee	3,314	4,580	--	--	1,620	2,561	2	2
Texas	10,108	13,932	11	11	3,068	4,419	1,045	664
Utah	1,853	2,341	--	--	379	348	4	1
Vermont	656	857	--	--	541	485	271	71
Virginia	3,326	4,989	--	--	2,654	2,773	27	3
Washington	3,228	4,721	--	--	1,249	1,723	343	364
West Virginia	1,772	2,938	--	--	415	687	--	--
Wisconsin	4,518	4,758	2,747	1,001	2,241	2,184	1,629	712
Wyoming	427	607	2	3	W	W	2,391	5,386
Undistributed	--	--	--	--	914	1,963	--	--
Total [3]	184,818	246,461	2,976	1,777	111,184	137,582	20,218	19,845
Puerto Rico [e] [p]	2,323	6,071	190	644	1,147	3,052	42	148

See footnotes at end of table.

Table 4.—Sand and gravel sold or used by producers in the United States in 1972, by State, use, and class of operation [1]—Continued

(Thousand short tons and thousand dollars)

State	Sand, construction—Continued									
	Railroad ballast (commercial)		Fill				Other [4]			
			Commercial		Government-and-contractor		Commercial		Government-and-contractor	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Alabama	W	W	98	94	--	--	W	W	--	--
Alaska	--	--	569	133	8	4	(2)	W	4	11
Arizona	W	W	579	655	57	13	105	285	--	--
Arkansas	--	--	341	365	72	73	W	W	--	--
California	W	W	4,338	3,560	1,154	397	231	514	2	4
Colorado	W	W	292	326	37	39	W	W	4	2
Connecticut	--	--	251	237	12	3	206	259	14	14
Delaware	--	--	W	W	--	--	W	W	--	--
Florida	--	--	W	1,770	--	--	W	W	--	--
Georgia	--	--	23	23	--	--	W	W	--	--
Hawaii	--	--	W	W	--	--	W	W	--	--
Idaho	--	--	W	W	25	16	W	W	1	1
Illinois	--	--	2,541	2,312	36	2	317	321	--	--
Indiana	--	--	984	780	6	6	100	97	7	7
Iowa	W	W	1,231	967	--	--	564	703	3	3
Kansas	W	W	1,254	907	16	4	69	113	--	--
Kentucky	--	--	704	661	--	--	139	190	--	--
Louisiana	--	--	408	261	22	57	W	W	138	256
Maine	--	--	319	141	10	2	128	79	33	8
Maryland	--	--	133	W	--	--	1	W	--	--
Massachusetts	9	14	809	485	179	38	596	810	48	49
Michigan	--	--	2,610	1,634	849	92	433	316	109	69
Minnesota	33	29	1,053	714	369	137	411	268	139	94
Mississippi	W	19	78	72	--	--	W	W	--	--
Missouri	--	--	341	242	--	--	167	302	--	--
Montana	--	--	10	13	15	2	W	W	7	5
Nebraska	--	--	568	407	--	--	W	W	--	--
Nevada	--	--	546	397	25	25	11	14	(2)	(2)
New Hampshire	--	--	636	532	--	--	57	55	--	--
New Jersey	W	W	1,105	705	--	--	66	78	--	--
New Mexico	--	--	175	113	64	30	W	W	4	5
New York	W	38	1,396	549	36	12	483	616	427	152
North Carolina	W	W	195	148	130	19	W	W	696	210
North Dakota	--	--	302	198	84	8	W	W	--	--
Ohio	W	W	1,563	1,178	--	--	96	143	--	--
Oklahoma	--	--	1,186	599	299	401	--	--	--	--
Oregon	3	45	575	1,430	2	(2)	W	W	--	--
Pennsylvania	W	W	100	129	--	--	1,456	1,817	--	--
Rhode Island	--	--	50	W	--	--	W	W	--	--
South Carolina	W	W	147	67	--	--	W	W	--	--
South Dakota	(2)	(2)	96	45	--	--	21	W	35	25
Tennessee	--	--	97	96	--	--	W	W	--	--
Texas	W	W	2,897	3,381	2	4	W	W	--	--
Utah	--	--	114	78	84	82	276	292	12	6
Vermont	--	--	42	28	--	--	64	76	--	--
Virginia	W	W	1,912	W	51	18	38	75	(2)	(2)
Washington	--	--	892	640	(2)	(2)	W	W	43	21
West Virginia	--	--	W	W	--	--	--	--	(2)	1
Wisconsin	W	W	1,391	832	348	97	190	149	483	179
Wyoming	--	--	43	W	2	(2)	16	W	2	1
Undistributed	998	1,042	9,579	3,137	--	--	1,122	1,597	--	--
Total [3]	1,045	1,186	44,571	31,045	3,996	1,581	7,363	9,169	2,212	1,121
Puerto Rico [e p]	657	714	--	--	--	--	--	--	--	--

See footnotes at end of table.

Table 4.—Sand and gravel sold or used by producers in the United States in 1972, by State, use, and class of operation [1]—Continued

(Thousand short tons and thousand dollars)

State	Sand, industrial (Commercial)									
	Glass		Molding		Grinding and polishing		Blast sand		Fire or furnace	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Alabama	--	--	W	W	--	--	--	--	--	--
Alaska	--	--	--	--	--	--	--	--	--	--
Arizona	--	--	--	--	--	--	(2)	W	191	696
Arkansas	W	W	W	W	--	--	--	--	--	--
California	878	4,547	W	W	--	--	223	1,095	W	W
Colorado	--	--	--	--	--	--	W	W	--	--
Connecticut	--	--	--	--	--	--	--	--	--	--
Delaware	--	--	--	--	--	--	--	--	--	--
Florida	W	W	--	--	--	--	118	967	--	--
Georgia	W	W	W	W	--	--	W	W	--	--
Hawaii	--	--	--	--	--	--	--	--	--	--
Idaho	--	--	--	--	--	--	6	55	--	--
Illinois	2,367	7,330	1,362	5,668	--	--	134	W	--	--
Indiana	W	W	W	W	--	--	--	--	--	--
Iowa	--	--	--	--	--	--	W	W	--	--
Kansas	--	--	--	--	--	--	--	--	--	--
Kentucky	--	--	--	--	--	--	10	46	--	--
Louisiana	--	--	W	W	--	--	120	720	--	--
Maine	--	--	--	--	--	--	--	--	--	--
Maryland	--	--	--	--	--	--	--	--	--	--
Massachusetts	--	--	W	W	--	--	W	W	--	--
Michigan	W	W	2,909	6,694	W	W	(2)	W	W	W
Minnesota	W	W	W	W	--	--	--	--	--	--
Mississippi	--	--	W	W	--	--	--	--	--	--
Missouri	697	2,237	W	W	W	W	W	W	W	W
Montana	--	--	--	--	--	--	--	--	--	--
Nebraska	--	--	--	--	--	--	--	--	--	--
Nevada	W	W	W	W	--	--	--	--	W	W
New Hampshire	--	--	--	--	--	--	--	--	--	--
New Jersey	1,915	W	493	2,496	W	W	138	842	W	W
New Mexico	--	--	--	--	--	--	--	--	--	--
New York	--	--	W	W	--	--	--	--	--	--
North Carolina	--	--	--	--	--	--	--	--	W	W
North Dakota	--	--	--	--	--	--	--	--	--	--
Ohio	--	--	171	566	--	--	W	W	W	W
Oklahoma	W	W	W	W	--	--	W	W	--	--
Oregon	--	--	--	--	--	--	--	--	--	--
Pennsylvania	W	W	W	W	W	W	W	W	W	W
Rhode Island	--	--	W	W	--	--	--	--	--	--
South Carolina	W	W	W	W	--	--	37	140	W	W
South Dakota	--	--	--	--	--	--	--	--	--	--
Tennessee	W	W	181	640	W	W	--	--	W	W
Texas	W	W	104	345	W	W	W	W	--	--
Utah	--	--	W	W	--	--	W	W	--	--
Vermont	--	--	--	--	--	--	--	--	--	--
Virginia	W	W	W	W	--	--	W	W	W	W
Washington	53	480	--	--	--	--	--	--	--	--
West Virginia	W	W	W	W	W	W	W	W	(2)	(2)
Wisconsin	W	W	W	W	--	--	W	W	--	--
Wyoming	--	--	--	--	--	--	--	--	--	--
Undistributed	4,917	26,664	2,302	8,416	262	731	286	2,412	513	1,546
Total [3]	10,828	41,259	7,522	24,827	262	731	1,072	6,278	703	2,243
Puerto Rico [e p]	--	--	--	--	--	--	--	--	--	--

See footnotes at end of table.

Table 4.—Sand and gravel sold or used by producers in the United States in 1972, by State, use, and class of operation [1]—Continued

(Thousand short tons and thousand dollars)

State	Sand, industrial (Commercial)—Continued									
	Engine		Filtration		Oil (hydrofrac)		Other		Ground sand	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Alabama	W	W	--	--	--	--	190	404	W	W
Alaska	--	--	--	--	--	--	--	--	--	--
Arizona	--	--	(2)	(2)	W	W	W	W	--	--
Arkansas	--	--	--	--	--	--	--	--	W	W
California	W	W	W	W	W	W	W	W	822	4,176
Colorado	W	W	W	W	W	W	--	--	--	--
Connecticut	--	--	--	--	--	--	--	--	--	--
Delaware	--	--	--	--	--	--	--	--	--	--
Florida	W	W	W	W	--	--	W	W	W	W
Georgia	W	W	W	W	--	--	W	W	W	W
Hawaii	--	--	--	--	--	--	--	--	--	--
Idaho	--	--	--	--	--	--	W	W	80	740
Illinois	W	W	W	W	W	W	489	W	396	2,259
Indiana	--	--	--	--	--	--	W	W	W	W
Iowa	--	--	--	--	--	--	W	W	W	W
Kansas	--	--	--	--	--	--	W	W	11	W
Kentucky	--	--	--	--	--	--	W	W	3	13
Louisiana	--	--	--	--	--	--	--	--	--	--
Maine	3	5	--	--	--	--	W	W	--	--
Maryland	--	--	--	--	--	--	--	--	--	--
Massachusetts	--	--	W	W	--	--	26	W	W	W
Michigan	28	73	--	--	--	--	W	580	W	W
Minnesota	W	W	--	--	W	W	46	104	W	W
Mississippi	--	--	--	--	--	--	--	--	--	--
Missouri	(2)	W	4	W	W	W	W	W	W	W
Montana	--	--	--	--	--	--	W	W	--	--
Nebraska	--	--	--	--	--	--	W	W	--	--
Nevada	--	--	--	--	--	--	W	W	2	5
New Hampshire	--	--	--	--	--	--	--	--	--	--
New Jersey	25	89	W	W	--	--	453	1,944	385	2,400
New Mexico	--	--	--	--	--	--	--	--	--	--
New York	19	W	W	89	--	--	W	W	W	W
North Carolina	--	--	W	W	--	--	W	W	--	--
North Dakota	--	--	--	--	--	--	--	--	--	--
Ohio	W	W	W	W	--	--	W	W	W	W
Oklahoma	--	--	--	--	W	W	W	W	W	W
Oregon	--	--	--	--	--	--	W	W	--	--
Pennsylvania	W	W	W	W	W	W	311	834	W	W
Rhode Island	--	--	--	--	--	--	--	--	--	--
South Carolina	W	W	W	W	--	--	W	W	W	W
South Dakota	--	--	--	--	--	--	--	--	--	--
Tennessee	W	W	--	--	--	--	W	W	W	W
Texas	(2)	W	W	W	W	W	285	1,086	W	W
Utah	W	W	--	--	--	--	--	--	W	W
Vermont	W	W	--	--	--	--	--	--	--	--
Virginia	29	95	--	--	--	--	5	1	1	2
Washington	--	--	--	--	--	--	W	W	--	--
West Virginia	W	W	(2)	W	--	--	W	W	W	W
Wisconsin	W	W	--	--	--	--	173	390	38	157
Wyoming	--	--	--	--	--	--	--	--	--	--
Undistributed	496	1,124	230	1,089	282	1,071	1,534	6,524	2,772	11,792
Total [3]	601	1,387	234	1,176	282	1,071	3,514	11,868	4,512	21,546
Puerto Rico [e] [p]	--	--	--	--	--	--	--	--	--	--

See footnotes at end of table.

Table 4.—Sand and gravel sold or used by producers in the United States in 1972, by State, use, and class of operation [1]—Continued

(Thousand short tons and thousand dollars)

State	Gravel, construction							
	Building				Paving			
	Commercial		Government-and-contractor		Commercial		Government-and-contractor	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Alabama	992	1,727	--	--	1,796	2,220	--	--
Alaska	199	436	--	--	991	1,841	6,784	8,075
Arizona	7,325	8,610	35	48	7,269	8,050	1,316	2,385
Arkansas	2,029	3,696	--	--	2,552	3,158	741	840
California	23,334	35,278	77	139	29,964	40,990	3,906	5,069
Colorado	4,849	8,199	103	193	11,096	13,026	4,224	3,306
Connecticut	925	1,791	(2)	(2)	995	1,593	723	1,621
Delaware	164	416	--	--	W	W	--	--
Florida	W	W	--	--	W	W	45	45
Georgia	W	W	--	--	--	--	--	--
Hawaii	W	W	--	--	W	W	25	3
Idaho	643	1,262	160	107	1,329	1,788	2,817	3,276
Illinois	6,632	8,574	3	2	8,590	12,175	298	286
Indiana	4,621	5,935	126	117	8,127	10,289	964	662
Iowa	1,164	2,148	--	--	5,111	5,418	1,103	809
Kansas	163	275	67	43	816	866	1,200	715
Kentucky	963	1,599	--	--	944	1,351	139	24
Louisiana	6,312	9,776	--	--	3,576	5,207	--	--
Maine	659	975	--	--	1,058	1,289	6,176	2,565
Maryland	3,706	8,715	--	--	919	1,918	157	38
Massachusetts	3,795	7,301	75	188	2,337	3,148	1,334	1,189
Michigan	7,344	11,037	127	90	17,942	19,204	2,508	1,290
Minnesota	4,697	7,290	36	18	12,166	10,483	4,883	2,707
Mississippi	2,831	3,724	68	180	5,373	6,588	--	--
Missouri	1,682	2,375	--	--	1,280	1,671	7	17
Montana	520	799	60	43	773	975	7,395	13,214
Nebraska	1,122	1,315	78	8	5,172	6,142	717	823
Nevada	1,974	2,294	4	3	2,842	3,885	1,556	1,109
New Hampshire	999	1,549	--	--	475	739	977	241
New Jersey	1,930	4,428	--	--	1,147	1,975	13	11
New Mexico	1,879	2,572	--	--	1,449	1,580	225	186
New York	5,594	9,684	--	--	3,265	4,953	1,120	365
North Carolina	1,224	2,422	--	--	1,097	1,431	552	292
North Dakota	665	1,204	135	110	2,864	2,107	1,521	909
Ohio	8,406	12,302	--	--	14,094	20,801	119	106
Oklahoma	120	188	4	22	120	130	31	4
Oregon	5,582	8,125	61	86	7,173	10,396	3,433	4,199
Pennsylvania	3,992	7,389	--	--	2,866	5,940	--	--
Rhode Island	374	679	--	--	385	791	15	15
South Carolina	W	W	--	--	--	--	--	--
South Dakota	340	506	26	18	3,760	3,994	6,675	8,080
Tennessee	2,797	3,403	38	3	1,600	2,036	358	166
Texas	9,506	17,588	38	34	3,497	7,464	982	944
Utah	2,314	2,512	--	--	5,231	7,259	2,261	2,705
Vermont	495	849	--	--	541	544	553	128
Virginia	2,359	4,478	--	--	1,292	2,025	31	27
Washington	4,353	6,156	35	59	5,939	7,491	2,948	1,853
West Virginia	1,200	2,102	--	--	W	W	--	--
Wisconsin	4,822	5,300	1,205	632	7,421	6,172	5,240	3,761
Wyoming	597	773	2	4	1,400	1,930	2,983	5,375
Undistributed	2,499	6,013	--	--	2,471	2,733	--	--
Total [3]	150,692	235,766	2,562	2,148	201,105	255,767	79,054	79,434
Puerto Rico [e p]	2,011	7,280	--	--	849	3,004	--	--

See footnotes at end of table.

Table 4.—Sand and gravel sold or used by producers in the United States in 1972, by State, use, and class of operation [1]—Continued

(Thousand short tons and thousand dollars)

State	Gravel, construction—Continued										Gravel miscellaneous (commercial)	
	Railroad ballast (commercial)		Fill				Other					
			Commercial		Government-and-contractor		Commercial		Government-and-contractor			
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Alabama	--	--	W	W	--	--	W	W	--	--	W	147
Alaska	W	W	1,800	841	70	72	107	32	205	41	50	W
Arizona	W	W	956	780	231	66	209	533	--	--	119	313
Arkansas	(2)	(2)	115	194	8	9	--	--	62	37	113	103
California	W	W	1,590	1,356	6,599	862	689	938	2	4	835	1,362
Colorado	90	105	370	352	1,337	425	187	294	31	1	506	581
Connecticut	--	--	319	235	63	43	125	221	--	--	142	197
Delaware	--	--	W	16	--	--	--	--	--	--	--	--
Florida	--	--	--	--	--	--	--	--	--	--	--	--
Georgia	60	90	W	W	--	--	63	133	--	--	8	17
Hawaii	--	--	2	3	--	--	--	--	--	--	--	--
Idaho	--	--	658	483	322	95	W	W	173	139	55	41
Illinois	W	W	1,528	1,504	18	35	304	368	(2)	(2)	312	371
Indiana	W	W	1,110	956	68	15	42	52	21	5	470	519
Iowa	W	W	187	186	--	--	1,156	1,204	4	1	107	167
Kansas	W	W	169	124	23	16	6	12	223	120	166	269
Kentucky	--	--	93	123	--	--	--	--	--	--	W	65
Louisiana	W	W	W	W	22	57	W	W	--	--	W	W
Maine	W	W	290	149	30	7	72	47	--	--	289	332
Maryland	--	--	428	514	--	--	W	W	--	--	652	W
Massachusetts	12	31	1,511	975	2	2	547	737	1	2	698	773
Michigan	W	W	288	283	420	26	2,737	2,152	68	18	1,716	1,464
Minnesota	110	105	1,941	574	387	161	291	251	213	94	775	921
Mississippi	2	W	W	W	--	--	--	--	--	--	103	122
Missouri	W	W	31	29	--	--	W	W	7	10	162	252
Montana	W	W	200	164	239	139	W	W	96	46	96	113
Nebraska	117	162	W	W	--	--	245	240	339	549	447	382
Nevada	--	--	471	520	70	49	434	543	--	--	W	W
New Hampshire	--	--	307	225	39	5	W	W	--	--	W	W
New Jersey	--	--	929	917	--	--	88	141	--	--	642	1,347
New Mexico	--	--	56	42	1,582	1,299	(2)	(2)	48	41	198	116
New York	--	--	1,135	905	462	72	119	158	54	21	573	663
North Carolina	W	W	38	41	--	--	W	W	--		115	185
North Dakota	W	W	226	182	90	11	W	W	65	9	31	55
Ohio	W	W	1,743	1,629	10	10	250	306	--	--	728	1,323
Oklahoma	--	--	W	W	7	7	12	24	--	--	(2)	W
Oregon	156	230	1,572	1,589	246	217	92	127	1	1	377	419
Pennsylvania	--	--	340	301	--	--	106	137	--	--	363	747
Rhode Island	--	--	W	W	--	--	--	--	--	--	149	130
South Carolina	--	--	W	W	--	--	W	W	--	--	--	--
South Dakota	W	W	195	112	18	5	W	W	118	118	334	399
Tennessee	W	W	93	110	--	--	--	--	--	--	259	229
Texas	W	W	2,023	2,885	37	13	W	W	--	--	128	114
Utah	W	W	459	251	528	211	952	799	78	78	42	35
Vermont	--	--	85	41	1	(2)	W	W	--	--	20	60
Virginia	--	--	W	W	1	(2)	W	131	--	--	20	25
Washington	189	178	1,579	958	1,380	301	290	444	52	30	464	594
West Virginia	W	W	W	W	--	--	--	--	--	--	--	--
Wisconsin	121	105	1,513	1,018	355	59	682	740	6	3	456	431
Wyoming	W	306	122	88	11	4	15	20	27	2	277	80
Undistributed	1,371	1,021	2,312	3,967	--	--	1,164	2,094	--	--	484	2,295
Total [3]	2,229	2,332	28,784	25,621	14,674	4,292	10,985	12,876	1,895	1,371	13,482	17,759
Puerto Rico [e] [p]	--	--	258	323	--	--	--	--	--	--	--	--

[e] Estimate. [p] Preliminary. W Withheld to avoid disclosing individual company confidential data, included with "Undistributed."

[1] Includes Puerto Rico.

[2] Less than ½ unit.

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

[4] Includes unspecified.

Table 5.—Sand and gravel sold or used by Government-and-contractor producers in the United States, by use [1]

(Thousand short tons and thousand dollars)

Year	Sand							
	Building		Paving		Fill		Other	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1968	819	893	35,550	27,297	7,327	3,997	2,615	1,920
1969	1,016	1,320	32,123	28,317	6,123	3,745	2,168	1,014
1970	883	1,058	43,130	41,965	5,234	2,195	1,632	834
1971	1,434	1,489	30,334	32,046	4,086	1,145	2,298	1,360
1972	2,976	1,777	20,218	19,845	3,996	1,581	2,212	1,121

Year	Gravel								Total Government-and-contractor sand and gravel [2]	
	Building		Paving		Fill		Other			
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1968	1,830	1,841	121,893	103,803	32,837	27,679	3,934	3,972	206,805	171,327
1969	1,976	2,522	133,127	116,774	28,240	19,481	1,423	890	206,189	174,070
1970	1,839	1,516	141,316	137,579	16,144	6,990	1,323	1,009	211,454	193,145
1971	2,857	2,667	96,453	98,410	7,723	2,981	2,033	1,143	147,212	141,229
1972	2,562	2,148	79,054	79,434	14,674	4,292	1,895	1,371	127,587	111,569

[1] Excludes American Samoa, Panama Canal Zone, and Puerto Rico.
[2] Data may not add to totals shown because of independent rounding.

Table 6.—Sand and gravel sold or used by Government-and-contractor producers in the United States, by type of producer [1]

(Thousand short tons and thousand dollars)

Type of producer	1968		1969		1970		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Construction and maintenance crews	62,939	42,146	65,786	45,691	67,238	39,446	58,820	30,428	62,072	36,013
Contractor	143,866	129,176	140,403	128,377	144,214	153,699	88,395	110,800	65,515	75,556
Total [2]	206,805	171,327	206,189	174,070	211,454	193,145	147,212	141,229	127,587	111,569
State	125,627	108,980	122,484	108,414	136,800	134,482	79,213	85,347	65,561	65,244
Counties	53,087	38,408	52,547	39,429	58,180	37,159	56,175	38,176	52,228	35,154
Municipalities	4,200	3,208	3,784	4,466	3,285	3,125	2,266	2,013	2,658	2,546
Federal agencies	23,891	20,731	27,374	21,761	13,189	18,379	9,558	15,693	7,141	8,624
Total	206,805	171,327	206,189	174,070	211,454	193,145	147,212	141,229	127,587	111,569

[1] Excludes American Samoa, Canal Zone, and Puerto Rico.
[2] Data may not add to totals shown because of independent rounding.

Table 7.—Sand and gravel sold or used by producers in the United States by class of operation and degree of preparation [1]

(Thousand short tons and thousand dollars)

	1971		1972	
	Quantity	Value	Quantity	Value
Commercial operations:				
Prepared	712,627	963,180	716,244	1,037,177
Unprepared	59,760	44,564	69,544	50,774
Total [2]	772,382	1,007,741	785,788	1,087,951
Government-and-contractor operations:				
Prepared	135,791	135,825	106,986	98,679
Unprepared	11,418	5,400	20,601	12,890
Total [2]	147,212	141,229	127,587	111,569
Grand Total [2]	919,593	1,148,969	913,375	1,199,520

[1] Excludes American Samoa and Puerto Rico.
[2] Data may not add to totals shown because of independent rounding.

Table 8.—Number and production of domestic commercial sand and gravel plants, by size of operation [1]

Annual production (short tons)	1971				1972			
	Plants [2]		Production		Plants [2]		Production	
	Number	Percent of total	Thousand short tons	Percent of total	Number	Percent of total	Thousand short tons	Percent of total
Less than 25,000	1,835	32.0	21,049	2.7	1,630	30.3	17,541	2.2
25,000 to 50,000	949	16.5	37,244	4.8	850	15.8	30,508	3.9
50,000 to 100,000	984	17.1	74,015	9.6	957	17.8	68,788	8.8
100,000 to 200,000	908	15.8	132,900	17.2	849	15.8	121,304	15.4
200,000 to 300,000	415	7.2	101,406	13.1	400	7.4	97,088	12.4
300,000 to 400,000	240	4.2	85,153	11.0	217	4.0	75,157	9.6
400,000 to 500,000	112	2.1	50,349	6.5	134	2.5	59,757	7.6
500,000 to 600,000	76	1.3	42,083	5.4	79	1.5	42,924	5.5
600,000 to 700,000	59	1.0	39,778	5.2	71	1.3	46,036	5.9
700,000 to 800,000	36	.6	26,877	3.5	56	1.0	41,860	5.3
800,000 to 900,000	33	.6	28,057	3.6	26	.5	22,310	2.8
900,000 to 1,000,000	21	.4	19,960	2.6	27	.5	25,666	3.3
1,000,000 and over	70	1.2	113,511	14.8	88	1.6	136,850	17.3
Total	5,738	100.0	772,382	100.0	5,384	100.0	[3] 785,788	100.0

[1] Excludes American Samoa and Puerto Rico.
[2] Includes a few companies operating more than 1 plant but not submitting returns for individual plants.
[3] Data may not add to totals shown because of independent rounding.

Table 9.—Sand and gravel sold or used in the United States, by class of operation and method of transportation [1]

	1971		1972	
	Thousand short tons	Percent of total	Thousand short tons	Percent of total
Commercial:				
Truck	699,339	76	707,868	77
Rail	43,286	4	44,675	5
Waterway	27,298	3	27,050	3
Unspecified	2,461	1	6,195	1
Total commercial [2]	772,382	84	785,788	86
Government-and-contractor: Truck [3]	147,212	16	127,587	14
Grand total [2]	919,593	100	913,375	100

[1] Excludes American Samoa and Puerto Rico.
[2] Data may not add to totals shown because of independent rounding.
[3] Entire output of Government-and-contractor operations assumed to be moved by truck.

Table 10.—Ground sand sold or used by producers in the United States,[1] [2] by use

(Thousand short tons and thousand dollars)

Use	1971 Quantity	1971 Value	1972 Quantity	1972 Value
Abrasives	171	1,706	204	1,938
Chemicals	26	220	141	568
Enamel	36	342	52	525
Filler	170	1,411	172	1,648
Foundry use	709	3,710	2,318	6,288
Glass	346	1,257	1,042	5,696
Pottery, porcelain, tile	187	1,958	221	2,261
Unspecified	268	2,291	362	2,623
Total [3]	1,911	12,893	4,512	21,546

[1] Includes Alabama (1972), Arkansas, California (1972), Connecticut (1971), Florida, Georgia, Idaho (1972), Illinois, Indiana, Iowa (1972), Kansas (1972), Kentucky, Louisiana (1971), Massachusetts (1972), Michigan, Minnesota, Missouri, Nevada, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee (1972), Texas, Utah, Virginia, West Virginia, and Wisconsin (1972).

[2] Excludes American Samoa and Puerto Rico.

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

Table 11.—U.S. imports for consumption of sand and gravel, by class

(Thousand short tons and thousand dollars)

Year	Glass sand [1]		Sand, n.s.p.f., crude or manufactured, and gravel		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1970	64	262	815	1,338	879	1,600
1971	48	243	667	984	715	1,227
1972	49	201	712	1,178	761	1,379

[1] Classification reads: Sands containing 95% or more silica and not more than 0.6% oxide of iron and suitable for manufacturing glass.

Silicon

By E. Shekarchi [1]

Major domestic producers of ferrosilicon and metallurgical-grade silicon engaged during 1972 in expansion toward specialization, and/or plant modernization to comply with 1975 antipollution standards set by local governments and the Federal Government.

Domestic production of ferrosilicon and silicon metal in 1972 increased sharply to meet the rising demands of a wide variety of products. However, increased production of ferrosilicon and silicon metal throughout the world led to severe price erosion both domestically and internationally. High-purity and ultra-high-purity silicon metal, though small in volume, continued to be an important element in the electronics industry; shipments were up 18%. The new demand for silicones as sealants for encapsulation of electric parts greatly increased during the year.

DOMESTIC PRODUCTION

On a gross weight basis, net production of ferrosilicon and silicon metal increased 18% in 1972 while shipments were 23% higher than in 1971. Silicon metal for metallurgical uses was produced at 11 plants of seven companies as shown in table 2.

Northwest Alloy, Inc., a newly formed subsidiary of Aluminum Co. of America (Alcoa), planned construction of a magnesium and silicon plant at Addy, Wash. Initial plant capacity will be 24,000 tons per year, and the final annual capacity will reach 40,000 tons. The plant will be the first of its kind in the United States to employ the megatherm (electrothermal) process with dolomite as raw material. This process, in operation at Marignac, France, since 1964, involves the reduction of calcined dolomite by ferrosilicon at a temperature in excess of 1,500° C. The magnesium and silicon metal extracted will be used by Alcoa and will make the company nearly self-sufficient in silicon metal. The Addy plant was scheduled to begin operation in 1975. It is to be the most modern and efficient environmentally controlled facility of its kind. Total cost has been estimated at $50 million.

[1] Physical scientist, Division of Ferrous Metals.

Table 1.—Production, shipments, and stocks of silvery pig iron, ferrosilicon, and silicon metal in 1972 [1]

(Short tons, gross weight)

Alloy	Silicon content (%)	Producers' stocks as of Dec. 31, 1971 [r]	Production	Shipments	Producers' stocks as of Dec. 31, 1972
Silvery pig iron	5-24	W	W	W	W
Ferrosilicon (includes briquets)	25-55	66,134	491,967	421,200	58,200
Do	56-70	14,812	59,672	63,145	10,025
Do	71-80	27,683	109,961	109,176	24,706
Do	81-95	2,144	9,089	9,889	1,312
Silicon metal (excludes semiconductor grades)	96-99	13,028	116,376	107,151	7,456
Miscellaneous silicon alloys (exclusive of silicomanganese)	--	10,136	58,282	52,515	10,568
Other silicon alloys and products	--	2,622	8,788	8,526	2,832

[r] Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Excludes ferrosilicon used to make other silicon alloys.

Table 2.—Producers of silicon alloys and/or silicon metal in the United States in 1972

Producers	Plant location	Product
Airco, Inc., Airco Alloys and Carbide Division	Calvert City, Ky	FeSi.
Do	Charleston, S.C	Do.
Do	Mobile, Ala	Do.
Do	Niagara Falls, N.Y	FeSi, Si.
Alabama Metallurgical Corp	Selma, Ala	FeSi.
Chromium Mining & Smelting Corp	Woodstock, Tenn	Do.
Foote Mineral Co	Graham, W. Va	FeSi, Si.
Do	Keokuk, Iowa	FeSi, Silvery iron.
Do	Vancoram, Ohio	FeSi.
Do	Wenatchee, Wash	FeSi, Si.
Hanna Furnace Corp	Buffalo, N.Y	Silvery iron.
Hanna Nickel Smelting Co	Riddle, Oreg	FeSi.
Interlake Steel Corp	Beverly, Ohio	FeSi, Si.
National Metallurgical Corp	Springfield, Oreg	Si.
Ohio Ferro-Alloys Corp	Brillant, Ohio	FeSi, Si.
Do	Philo, Ohio	Do.
Do	Powhatan Point, Ohio	Do.
Do	Tacoma, Wash	Do.
Reynolds Metals Co	Sheffield, Ala	Si.
Tennessee Alloys Corp	Bridgeport, Ala	FeSi.
Union Carbide Corp., Ferroalloys Division	Alloy, W. Va	FeSi, Si.
Do	Ashtabula, Ohio	FeSi.
Do	Marietta, Ohio	Do.
Do	Portland, Oreg	Do.
Do	Sheffield, Ala	Do.
Do	Woodward, Ala	Do.
Woodward Corp	Rockwood, Tenn	Do.
Do		

Allegheny Ludlum Steel Corp., a major producer of grain-oriented silicon electrical steels, announced a $15 million expansion and improvement program exclusively for the silicon facilities at its Bagdad processing plant in Bagdad, Pa.

Standard Resources Inc. of Nevada expected to be producing market-ready silica flour at a rate of 150 tons per day early in 1973. The material will be marketed as minus 200-mesh or plus 200-mesh silica flour ready for bagging, or for bulk shipment.

CONSUMPTION AND USES

New uses for semiconductors and transistors included transistorized circuitry in electronic stoves, tiny semiconductors in diagnostic computer systems, and large numbers of integrated circuits. U.S. factory shipments of semiconductors in 1972 were

Table 3.—Consumption, by major end use, and stocks of silicon alloys and metal in the United States in 1972

(Short tons)

	Silicon content (%)						Miscellaneous silicon alloys [2]
	Silvery pig iron 5–24	Ferrosilicon [1] 25–55	Ferrosilicon [1] 56–70	Ferrosilicon [1] 71–80	Ferrosilicon [1] 81–95	Silicon metal 96–99	
Steel:							
Carbon	3,136	103,544	10,516	24,787	1,238	1,005	17,938
Stainless and heat-resisting	W	17,975	261	9,239	169	70	505
Full alloy	594	35,834	1,531	12,457	1,329	1,106	1,517
High-strength low-alloy	2,222	8,050	W	1,506	W	W	W
Electric	--	1,113	W	W	W	W	--
Tool	--	2,090	W	602	W	W	W
Cast irons	197,273	223,906	11,802	29,673	7,213	23	73,979
Superalloys	--	304	W	10	W	W	W
Alloys (excludes alloy steels and superalloys)	367	2,567	W	278	8,777	51,414	7,954
Miscellaneous and unspecified	4,571	6,539	578	20,902	691	30,133	2,846
Total	208,163	401,922	24,688	99,454	19,417	83,751	104,739
Consumers stocks, Dec. 31, 1972	62,067	30,501	2,023	6,856	1,923	5,692	24,519

W Withheld to avoid disclosing individual company confidential data; included in "Miscellaneous and unspecified."

[1] Includes briquets.

[2] Includes magnesium-ferrosilicon and other silicon alloys.

18% higher than in 1971. Large producers of semiconductors, Texas Instruments, Inc., Motorola Inc., and Fairchild Camera & Instrument Corp., were expanding their production facilities to meet anticipated domestic and foreign demands in 1973.

The range of application of the new silicones, Room Temperature Volcanizers (RTV), increased significantly in 1972. These new products can be poured or spread as a paste which cures to an elastomeric solid at room temperature. The key to this behavior is a chemical reaction which takes place under the catalytic influence of dibutyltin dilaurate, a tin compound. The elastomeric solids were used as sealants in building and engineering, in the production of molds for casting plastics and low-melting-point metals, for coating paper, and for encapsulation of electrical parts.

The consumption patterns of ferrosilicon and silicon metal in the steel and aluminum industries were similar to those of previous years. However, it was predicted by automakers that more silicon alloys would be used in the production of engine castings for economy-size cars in the coming years.

PRICES

The f.o.b. price of 50% ferrosilicon was decreased in March 1972 from 16 to 15 cents per pound contained silicon, bulk, carload lots. The price remained unchanged for the remainder of the year.

Metallurgical-grade silicon, 98% minimum silicon, 0.35% maximum iron, was quoted throughout the year at 25.4 cents per pound. Amorphous silica in 50-pound paper bags, 200 mesh, 90 to 95% silicon, was quoted at $26 per ton, and 98 to 99% silicon was priced at $27 per ton at yearend.

Despite improved steel demand, ferrosilicon prices generally were stable during the year. There appeared to be a tendency in the steel industry to hold raw material inventories down, and buyers were hesitant to make long-term commitments.

FOREIGN TRADE

During 1972 net trade in ferrosilicon, though active, continued to be unfavorable to the United States. Exports decreased 71% in volume and about 61% in value; major recipients were Canada, 3,335 tons; West Germany, 1,617 tons; and the United Kingdom, 1,275 tons. Nineteen countries received shipments ranging in quantity from 1 to 6 tons.

Imports of ferrosilicon and silicon metal for consumption increased 75% in volume and 83% in value over those of 1971. Major increases were in the silicon metal categories. For example, silicon metal imports of not more than 99.7%silicon increased eighteen fold by volume in 1972 compared with 1971 imports. Table 5 has been expanded to include the higher silicon content categories, as reported by the Bureau of the Census.

Table 4.—U.S. exports of ferrosilicon

Year	Quantity (short tons)	Value (thousands)
1970	44,694	$11,887
1971	25,506	5,603
1972	7,367	2,196

Table 5.—U.S. imports for consumption of ferrosilicon and silicon metal, by grade and country

Grade and country	1970 Quantity (short tons)		1970 Value (thousands)	1971 Quantity (short tons)		1971 Value (thousands)	1972 Quantity (short tons)		1972 Value (thousands)
	Gross weight	Silicon content		Gross weight	Silicon content		Gross weight	Silicon content	
Ferrosilicon:									
Over 8% but not over 60% silicon:									
Canada	9,450	1,738	$652	6,039	987	$419	6,579	1,043	$419
Denmark	--	--	--	--	--	--	113	51	37
France	1,395	670	473	1,388	624	492	2,553	1,245	936
Germany, West	402	200	119	276	127	75	552	305	226
Italy	80	38	21	--	--	--	--	--	--
Japan	2,035	958	595	3,587	1,687	1,111	2,466	1,174	736
Norway	59	26	18	685	304	213	2,205	980	684
Spain	--	--	--	--	--	--	57	26	16
Total	13,421	3,630	1,878	11,975	3,729	2,310	14,525	4,824	3,054
Over 60% but not over 80% silicon:									
Belgium-Luxembourg	--	--	--	--	--	--	55	37	23
Canada	4,722	3,648	908	791	603	215	949	715	240
Denmark	--	--	--	44	26	17	--	--	--
France	2,676	1,634	1,010	2,836	1,744	1,129	4,538	2,806	1,791
Germany:									
East	28	21	10	--	--	--	--	--	--
West	405	248	128	444	270	162	56	35	21
Japan	--	--	--	50	38	10	--	--	--
Netherlands	--	--	--	--	--	--	2,894	2,205	433
Norway	620	464	92	2,569	1,919	736	9,159	6,935	1,549
South Africa, Republic of	433	330	69	318	246	63	157	120	34
Sweden	--	--	--	3,114	2,307	541	4,901	3,632	1,256
Taiwan	--	--	--	28	20	7	--	--	--
Turkey	--	--	--	--	--	--	2,211	1,697	367
Yugoslavia	--	--	--	2,224	1,718	r 539	--	--	--
Total	8,884	6,345	2,217	12,418	8,891	r 3,419	24,920	18,182	5,714
Over 80% but not over 90% silicon:									
Canada	--	--	--	60	51	18	--	--	--
South Africa, Republic of	99	85	22	14	12	3	--	--	--
Total	99	85	22	74	63	21	--	--	--
Over 90% silicon content:									
France	--	--	--	--	--	--	40	38	12
Norway	--	--	--	--	--	--	115	110	35
Total	--	--	--	--	--	--	155	148	47
Grand total	22,404	10,060	4,117	24,467	12,683	r 5,750	39,600	23,154	8,815
Silicon metal:									
Not over 99.7% silicon:									
Canada	400	363	108	174	173	74	790	780	385
France	--	--	--	--	--	--	121	120	46
Germany, West	--	--	--	--	--	--	(1)	(1)	(1)
Italy	26	25	9	--	--	--	1,681	1,657	584
Japan	(1)	(1)	11	--	--	--	--	--	--
Norway	--	--	--	22	21	8	594	583	216
United Kingdom	1	(1)	1	2	1	2	276	272	97
Yugoslavia	--	--	--	--	--	--	61	55	18
Total	427	388	129	198	195	84	3,523	3,467	1,346

See footnotes at end of table.

Table 5.—U.S. imports for consumption of ferrosilicon and silicon metal, by grade and country—Continued

Grade and country	1970 Quantity (short tons) Gross weight	1970 Quantity (short tons) Silicon content	1970 Value (thousands)	1971 Quantity (short tons) Gross weight	1971 Quantity (short tons) Silicon content	1971 Value (thousands)	1972 Quantity (short tons) Gross weight	1972 Quantity (short tons) Silicon content	1972 Value (thousands)
Silicon metal—Continued:									
Over 99.7% silicon:									
Belgium-Luxembourg	(1)	(1)	$71	(1)	(1)	$4	(1)	(1)	$38
Canada	--	--	--	--	--	--	1	1	2
Denmark	(1)	(1)	83	(1)	(1)	44	(1)	(1)	73
France	(1)	(1)	(1)	2	2	92	1	1	35
Germany, West	30	30	2,422	12	12	1,173	53	53	3,318
Italy	(1)	(1)	(1)	--	--	--	--	--	--
Japan	15	15	899	17	17	607	5	5	450
Switzerland	1	1	16	--	--	--	--	--	--
United Kingdom	1	1	127	(1)	(1)	(1)	(1)	(1)	7
Total	47	47	3,618	31	31	1,920	60	60	3,923
Grand total	474	435	3,747	229	226	2,004	3,583	3,527	5,269

r Revised.
1 Less than ½ unit.

WORLD REVIEW

India.—The two major ferrosilicon producers in India were the public sector, Mysore Iron and Steel, Ltd., at Bhadravati and the private sector, Indian Metals and Ferroalloys Ltd., at Bhubaneshwar, Orissa. Output of ferrosilicon and silicon metal during 1972 was approximately 19,000 tons, a slight increase over 1971 production.

The Government Planning Commission estimated that India will consume all of its 1973 ferrosilicon production and that the demand will increase to 31,500 tons by 1975 and to 46,000 by 1980.

Italy.—Construction of a new plant in Sicily which will produce about 148,800 tons per year of silicon metal, ferrosilicon, and ferrochrome continued in 1972. Most of the raw material, except chromite, will come from the plant vicinity.

Japan.—Kanabe Kokoki, which built a completely sealed nonrotating, 45,000-kilovolt-ampere ferrosilicon plant in 1968, completed the construction of two fully sealed rotating electric furnace plants early in 1972. One of these plants, which belongs to Yahagi Iron Company of Nagoya, Japan, reportedly produced 36,000 tons of 50% ferrosilicon in a fully enclosed, pollution-free 60,000-kilovolt-ampere electric furnace without any poking. The other plant, which belongs to Joetsu Ferroalloy Company, has the same specifications and was utilized in the production of 75% ferrosilicon.

Of the estimated 300,000 tons of ferrosilicon produced by Japan in 1972, more than half was of 75% ferrosilicon grade, reflecting a trend toward specialization.

Norway.—The construction of two new electric furnaces for production of silicon metal was completed in 1972. One of the furnaces, belonging to Bremanger Smelteverk, a division of Elkem-Spigerverket, increased the production capacity at its Svelgen plant to 10,000 tons of silicon metal per year. The other furnace, belonging to A/S Meraker Smelteverk, a subsidiary of Union Carbide Corp., has a production capacity of 14,000 tons of silicon metal per year.

Exports of silicon metal from Norway in 1972 totaled 42,000 tons, a 62% increase compared with 1971 exports.

South Africa, Republic of.—A new submerged arc electric furnace, reportedly the largest in South Africa, was commissioned in May 1972 at the Ferrometals Ltd. plant in Witbank. Ferrometals Ltd. is a subsidiary of African Metals Corp., Ltd. (AMCOR), which supplies most of the South African domestic market with metallurgical-grade silicon, ferrosilicon, and other alloys. The furnace has a trans-former capacity of 48 megavolt amperes and was built at a cost of about $4.2 million.

From 1966 to the end of 1971 South African exports of ferrosilicon were reduced drastically in order to meet the needs of the expanding domestic market. However, with the start of new facilities, producers predict an increase of ferrosilicon exports in excess of $7 million per year.

Silver

By J. R. Welch [1]

Domestic mine output of silver was down 10% to 37.2 million ounces. This was 4.3 million ounces less than in 1971, the drop being mainly attributable to an extensive fire at the Sunshine mine in Idaho. Imports exceeded exports in 1972 by 35.7 million ounces, and consumption increased by 17% to 151.1 million ounces (exclusive of coinage). Silver prices fluctuated widely but displayed a rising trend throughout 1972. On January 3 the price was 138.7 cents per ounce, which was the low for the year. A high of 204.8 cents per ounce was reached on December 26, and at yearend the price was 204.2 cents.

While U.S. silver consumption for industrial uses increased significantly, its usage in coinage remained about the same as that in 1971 at 2.3 million ounces. The use of silver for all industrial purposes increased, except for use in bearings. Silver used in commemorative coins and medals rose sharply to an estimated 11.5 million ounces. Trading volume on the New York Commodity Exchange (COMEX) was up 32% over that of 1971. Treasury stocks declined 5% to 45.81 million ounces compared with 48.00 million ounces at the end of 1971. COMEX stocks declined 37.89 million ounces (33%), and during the same period, the stocks of the Chicago Board of Trade increased by 9.78 million ounces (75%). Industrial stocks declined to 152.46 million ounces compared with 185.34 million ounces at the end of 1971.

[1] Physical scientist, Division of Nonferrous Metals.

Table 1.—Salient silver statistics

	1968	1969	1970	1971	1972
United States:					
Mine production ---- thousand troy ounces	32,729	41,906	45,006	41,564	37,233
Value ---- thousands	$70,191	$75,040	$79,697	$64,258	$62,737
Ore (dry and siliceous) produced:					
Gold ore ---- thousand short tons	2,003	2,002	2,092	1,883	1,583
Gold-silver ore ---- do	199	216	104	167	180
Silver ore ---- do	701	755	674	673	447
Percentage derived from—					
Dry and siliceous ores	39	36	33	37	25
Base metal ores	61	64	67	63	75
Refinery production [1] ---- thousand troy ounces	37,199	43,769	49,451	37,242	38,366
Exports [2] ---- do	125,761	88,909	27,614	12,224	29,657
Imports, general [2] ---- do	70,709	71,876	62,300	57,962	65,406
Stocks Dec. 31:					
Treasury [3] ---- million troy ounces	256	104	25	48	46
Industry [4] ---- thousand troy ounces	166,356	198,790	210,150	r 185,335	152,461
Consumption:					
Industry and the arts ---- do	145,293	141,544	128,404	129,146	151,063
Coinage ---- do	36,833	19,407	709	2,474	2,284
Price [5] ---- per troy ounce	$2.144+	$1.790+	$1.771−	$1.542−	$1.685−
World:					
Production ---- thousand troy ounces	275,264	295,718	300,991	288,883	291,391
Consumption: [6]					
Industry and the arts ---- do	r 350,800	r 366,500	r 357,100	r 359,800	382,000
Coinage ---- do	89,300	r 40,000	r 33,600	r 27,300	40,500

r Revised.
[1] From domestic ores.
[2] Excludes coinage.
[3] Excludes silver in silver dollars.
[4] Includes silver in COMEX warehouses and silver registered to Chicago Board of Trade.
[5] Average New York price. Source: Handy & Harman.
[6] Free world only. Source: Handy & Harman.

Table 2.—Salient silver statistics

(Million troy ounces unless otherwise noted)

Year	U.S. mine production	Imports [1]	Exports [1]	U.S. consumption [2]	World production	World consumption [1,3]	Price (per troy ounce) [4]	World coinage [3]	Idaho production
1925	66.71	93.50	137.16	29.90	245.88	231.8	$0.69	20.3	7.74
1926	62.49	112.00	142.90	29.40	253.62	243.5	.62	10.8	7.56
1927	59.63	95.80	132.68	28.40	250.48	263.1	.57	6.5	8.90
1928	57.87	114.90	146.08	24.90	257.37	294.8	.58	13.6	9.00
1929	60.86	109.10	143.98	30.90	260.60	302.9	.53	25.0	9.41
1930	47.73	100.20	133.94	26.80	245.81	298.2	.38	20.1	9.42
1931	29.86	81.50	1,331.02	24.30	194.96	241.2	.29	21.1	7.22
1932	22.74	59.30	41.96	14.40	163.80	162.9	.28	47.9	6.72
1933	23.13	162.40	44.18	10.80	172.03	256.4	.35	11.5	6.99
1934	32.78	175.80	21.25	11.40	192.93	422.4	.48	21.0	7.39
1935	48.52	521.20	5.73	5.20	224.39	592.4	.64	17.6	10.24
1936	61.15	237.30	3.94	19.10	252.36	496.7	.45	10.7	14.54
1937	71.41	157.20	3.46	27.70	277.81	450.2	.45	28.3	19.59
1938	61.71	246.10	3.31	20.10	264.23	484.8	.43	25.5	18.99
1939	64.37	193.90	21.94	44.60	266.31	435.6	.39	8.9	17.22
1940	70.44	166.10	9.40	44.40	269.24	NA	.35	NA	17.55
1941	67.05	134.30	8.40	72.43	251.51	NA	.35	NA	16.67
1942	54.09	108.00	1.41	101.40	242.12	NA	.38	NA	14.65
1943	41.46	62.80	34.38	118.00	196.13	NA	.45	NA	11.70
1944	34.47	51.30	137.25	120.10	172.62	NA	.45	NA	9.93
1945	29.02	50.60	70.05	126.30	152.52	NA	.52	NA	8.14
1946	22.92	61.60	39.79	87.00	127.53	NA	.80	NA	6.49
1947	35.82	83.80	21.21	98.50	154.90	NA	.72	NA	10.35
1948	38.10	84.98	5.43	105.29	173.18	NA	.74	NA	11.45
1949	34.68	95.79	3.00	88.00	179.25	132.5	.72	83.8	10.05
1950	42.46	108.05	4.60	110.00	203.04	157.4	.74	44.1	16.10
1951	39.76	81.00	6.39	105.00	199.15	165.0	.89	90.5	14.75
1952	39.45	75.52	2.00	96.50	215.02	142.1	.85	114.3	14.92
1953	37.57	81.50	1.02	106.00	221.61	168.3	.85	90.7	14.64
1954	36.94	90.90	1.69	86.00	215.78	160.8	.85	83.4	15.87
1955	37.20	84.52	4.90	101.40	225.15	192.8	.89	52.6	13.83
1956	38.72	162.83	5.50	100.00	225.54	215.9	.91	56.6	13.47
1957	38.16	206.12	10.30	95.40	230.55	212.6	.91	84.2	15.07
1958	34.11	165.97	2.73	85.50	236.30	190.5	.89	79.5	15.95
1959	31.19	69.09	9.18	101.00	230.46	212.9	.91	86.4	16.64
1960	30.77	60.66	26.59	102.00	235.21	224.6	.91	103.9	13.65
1961	34.79	50.26	39.83	105.50	236.96	239.5	.92	137.1	17.58
1962	36.80	76.36	13.06	110.40	245.77	258.5	1.09	127.6	17.77
1963	35.24	59.06	31.49	110.00	249.98	260.7	1.28	166.4	16.71
1964	36.33	51.67	109.40	123.00	243.55	299.2	1.29	267.1	16.48
1965	39.81	54.71	39.67	137.00	257.42	336.6	1.29	381.1	18.46
1966	43.67	63.03	85.54	183.70	266.73	355.1	1.29	129.5	19.78
1967	32.34	55.52	70.77	171.03	258.20	348.7	1.55	105.3	17.03
1968	32.73	70.71	125.76	145.29	275.26	350.8	2.14	89.3	15.96
1969	41.91	71.88	88.91	141.54	295.72	366.5	1.79	40.0	18.93
1970	45.01	62.30	27.61	128.40	300.99	357.1	1.77	33.6	19.11
1971	41.56	57.96	12.22	129.15	288.88	359.8	1.54	27.3	19.14
1972	37.23	65.41	29.66	151.06	291.39	382.0	1.69	40.5	14.25

NA Not available.
[1] Excludes coinage.
[2] Source: U.S. Bureau of the Mint, 1925–1966.
[3] Free world only. Source: Handy & Harman.
[4] Average New York price. Source: Handy & Harman.

Legislation and Government Programs.—There was no legislation pertaining to silver enacted during 1972. Public Law 91–607, enacted December 31, 1970, provided for the minting of 150 million 40% silver, clad Eisenhower dollars during 1971–75 to be sold at premium prices of $10 for proof coins and $3 for others and, in addition, for minting composite cupronickel Eisenhower dollars and Kennedy half-dollars for general circulation. This program proceeded as planned during 1972. In 1972, the Office of Minerals Exploration (OME) of the U.S. Geological Survey negotiated two contracts involving silver totaling $163,620. One prospect is located in the McGrath quadrangle in Alaska, and the other is located in Lander County, Nev. Silver remains one of the minerals eligible for government financial assistance of 75% of the allowable costs of exploration.

DOMESTIC PRODUCTION

Mine output of recoverable silver in the United States was 4.3 million ounces below that of 1971 mainly due to the underground fire in the Sunshine mine in Idaho. Base metal ores provided 75% of the total silver output, and silver ores provided 24%, with the remainder coming from gold and gold-silver production. Idaho's production decreased 26% compared with 1971 production and amounted to 38% of the U.S. production. Total output of silver in Arizona, Colorado, Montana, and Utah remained about the same as in 1971, and the combined production of these four States and Idaho was 86% of the domestic production.

The 25 leading silver producers contributed 85% of the total output. Four of the leading producers (1st, 2nd, 6th and 8th) mined silver ores alone, and the rest were base metal producers. Nine mines produced over 1 million ounces of silver each. Domestic mine output provided almost 25% of the silver consumed by industry and the arts.

In 1972, Hecla Mining Co., Wallace, Idaho, reported the production of 4.47 million ounces of silver, down about 30% from the 1971 output. The average selling price of its silver in 1972 was $1.67 per ounce, as compared with $1.54 per ounce in 1971 and $1.76 per ounce in 1970. Hecla's wholly owned Lucky Friday mine, located in Idaho's Coeur d'Alene district, produced 2.75 million ounces of silver, 19,500 tons of lead, and lesser amounts of zinc, copper, and gold by processing 192,000 tons of ore averaging 14.62 ounces of silver per ton. Ore reserves at the end of 1972 were up nearly 6% to 584,000 tons.

Hecla also owned approximately one-third of the ore produced by the Nation's leading silver producer, the Sunshine mine. During 1972, a major underground fire, which claimed the lives of 91 men, resulted in closure of the mine from May 2 until December 8, 1972. As a result, Hecla's share of the Sunshine production was 33,738 tons of ore assaying 27.32 ounces per ton, compared with 84,212 tons of ore assaying 27.34 ounces of silver per ton in 1971.

In addition to the Sunshine mine, Hecla owns a 30% interest in the Star Unit mine, also located in the Coeur d'Alene district. Hecla's share of production from this property was 208,000 ounces of silver, and substantial tonnages of lead and zinc.

During 1972, Hecla operated the Mayflower mine in the Park City district, Utah, under a leasing arrangement with the New Park Mining Co. Production totaled 114,604 tons of ore assaying 0.46 ounce of gold and 5.95 ounces of silver per ton, 3.22% lead, 2.01% zinc, and 1.35% copper. The mine was closed at yearend, and the agreement with New Park was terminated.

The Galena mine in the Coeur d'Alene district, Idaho, was operated by the American Smelting & Refining Co. (ASARCO). At the Galena mine, under lease from the Callahan Mining Corp., ASARCO produced 4,222,000 ounces of silver from 190,204 tons of ore averaging 22.75 ounces of silver per ton and 0.81% copper.

Kennecott Copper Corp. reported silver production of 4,335,074 ounces in 1972 from processing 58.5 million tons of copper ore. This compared with 3,711,141 ounces produced in 1971 from processing 59.3 million tons of copper ore.

The Bunker Hill Co. produced a total of 3.82 million ounces of silver in 1972, about the same as that in 1971. About 1.53 million ounces of the total was produced at the Crescent mine in 1972 compared with 1.70 million ounces in 1971.

Smelter and refinery reports in 1972 showed that 31.1 million ounces of silver was produced from old scrap and 31.8 million ounces was produced from new scrap compared with 1971 data for old and new scrap of 30.1 million and 16.5 million ounces, respectively. Refinery production, including silver from domestic and imported sources, totaled 140.4 million ounces in 1972 compared with 115.3 million ounces in 1971.

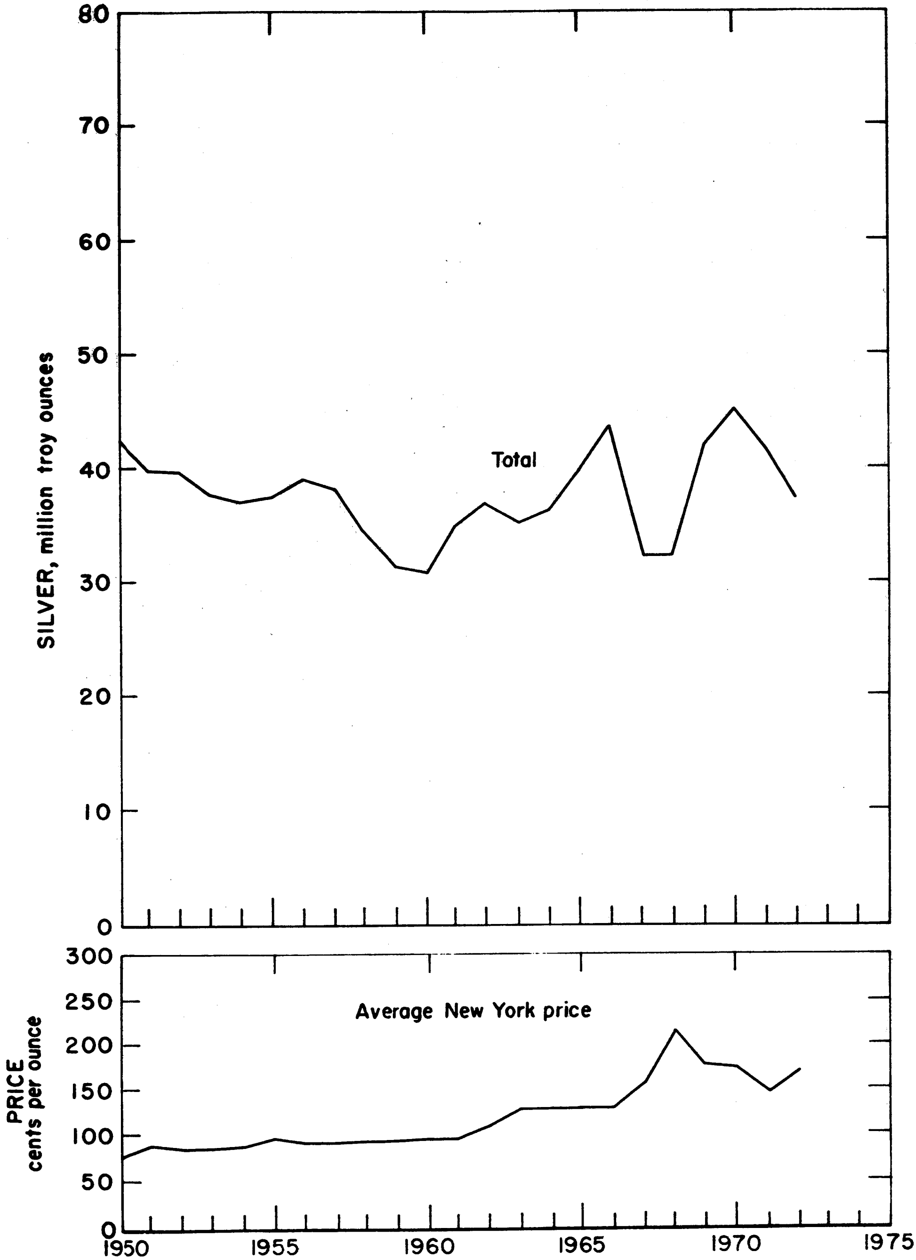

Figure 1.—Silver production in the United States and price per ounce.

CONSUMPTION AND USES

Consumption as measured by sales to consuming industries, compiled by the Bureau of Mines, showed a 17% increase compared with that of 1971. There were significant increases in use in sterling ware, photography, and contacts and conductors. Substantial increases were registered for use in catalysts, jewelry, and electroplated ware, and a large increase in usage was shown for commemorative medals and other collector items, estimated at 11.5 million ounces in 1972 compared with 6 million ounces in 1971. A slight decline was recorded for silver usage in bearings. Photographic materials accounted for about 25% of the total industrial consumption of silver in 1972; contacts and conductors, 24%; sterling ware, 18%; electroplated ware, 8%; brazing alloys and solders, 8%; miscellaneous, 4%; and batteries, 4%. The remaining 9% was used in jewelry, catalysts, dental and medical supplies, mirrors, and bearings.

Use of silver in coinage by the U.S. Bureau of the Mint declined slightly to 2.3 million ounces compared with 2.5 million ounces used in 1971. The silver consumed was used in the production of the 40% silver Eisenhower dollar.

Engelhard Minerals & Chemicals Corp. reported development of a new electrical heating device for defrosting the rear windows of cars. It was installed in some of the 1972 model cars produced in the United States, and more cars are expected to use the device in 1973 and 1974.[2]

A new nonacid silver solder brazing flux was reported to have been developed by Superior Flux & Manufacturing Co.; the flux did not generate free fluorides or other harmful fumes.[3]

STOCKS

The Treasury bullion stock outflow in 1972 totaled 2.3 million ounces, all of which was consumed in U.S. coinage use for the continued production of the Eisenhower silver dollar.

Yearend Treasury stocks were estimated at 45.8 million ounces in bullion, coin bars, and coinage metal fund silver. COMEX silver stocks at yearend 1972 were 77.6 million ounces compared with 115.4 million ounces a year earlier. Chicago Board of Trade stocks at yearend were 22.8 million ounces compared with 13.0 million ounces a year earlier. U.S. Defense Department stocks totaled 8.9 million ounces. Stocks of silver held by refiners, fabricators, and dealers decreased slightly to 52.1 million ounces. Altogether, yearend visible stocks totaled 207.1 million ounces compared with 241.2 million ounces at the end of 1971.

PRICES

Silver prices in New York in 1972, as quoted daily by Handy & Harman, in cents per troy ounce, varied widely, ranging from a low of 138.7 on January 3, 1972, to a high of 204.8 on December 26, 1972. The average price for silver during 1972 was 168.5 cents per ounce in New York.

Prices for spot delivery on the London Bullion Market (U.S. equivalent) ranged from a low of 137.3 cents per ounce on January 3, 1972, to a high of 203.3 cents per ounce on December 29, 1972, and averaged 167.7 cents for the year.

The price rise in the United States was such that by April the market had been brought to within a few cents of a 161.6 cents-per-ounce ceiling price stipulated by the Federal Price Commission as part of price-inflation control measures placed in effect earlier. By July silver prices had exceeded the ceiling price, with the result that a substantial amount of silver was exported. On August 10 the Cost of Living Council exempted silver from price controls. Thereafter, silver prices continued to rise through August but declined in September. In October the market stabilized but then resumed an upward trend

[2] American Metal Market. Silver Circuit Used in Defrost Unit. V. 79, No. 112, June 15, 1972, p. 14.

[3] American Metal Market. New Non-Acid Silver Brazing Solder Flux. V. 79, No. 228, Dec. 13, 1972, p. 6.

throughout the rest of the year and ended December at 204.2 cents per troy ounce.

Futures trading of silver continued on the COMEX, with the volume for the year at 7.9 billion ounces compared with 6.2 billion ounces in 1971. A monthly record trading of 1.26 billion ounces took place in December. December's closing prices for future delivery, in cents per ounce, were 204.0 (January 1973), 210.5 (September 1973), and 217.4 (May 1974). Silver futures trading was also active on the Chicago Board of Trade, where 3.8 billion ounces were traded in 1972. This was a 52.0% increase over the volume of contracts traded in 1971.

FOREIGN TRADE

Silver exports increased 143% in 1972 to 29.7 million ounces. This compares with 12.2 million ounces exported in 1971. About 37% of the silver exported went to the United Kingdom, 16% went to Switzerland, 16% to France, and 14% went to West Germany. Substantial quantities went to Japan, Belgium-Luxembourg, and Canada. Exports of waste, scrap, and sweepings went mainly to Belgium-Luxembourg, the United Kingdom, and West Germany, and bullion went mainly to the United Kingdom, Switzerland, France, and West Germany.

Silver imports increased in 1972 to 65.4 million ounces, about 13% more than the 58.0 million ounces imported in 1971. The main sources of imports were Canada (50%), Peru (25%), and Mexico (11%), with 21 other countries providing the remaining 14%.

Net imports were 35.7 million ounces in 1972 compared with 45.7 million ounces in 1971.

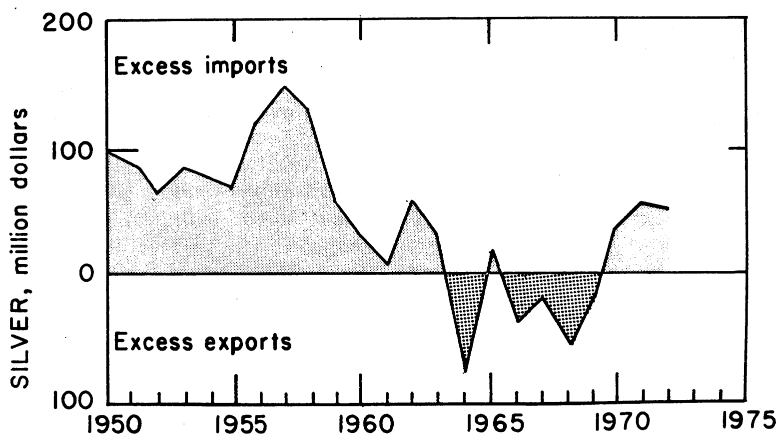

Figure 2.—Net exports or imports of silver, 1950–1972.

WORLD REVIEW

World output of silver amounted to 291.4 million ounces, about 2.5 million more than that of 1971. Peru showed the largest increase and the United States showed the largest drop, owing to the extended closure of the Sunshine mine in Idaho. Increases in production were also reported in Canada and Mexico. Western Hemisphere output of silver provided about 61% of the total world production.

World consumption in arts and industry was estimated at 382 million ounces, up about 22 million ounces over that consumed in 1971.[4] The United States showed

[4] Handy & Harman. The Silver Market, 1972. 57th Annual Rev., 1972, 23 pp.

the largest increase in consumption, from 129.1 million ounces in 1971 to 151.1 million ounces in 1972. Coinage requirements of silver for the world increased from 27.3 million ounces in 1971 to 40.5 million ounces in 1972. Total free world consumption exceeded production by 90.6 million ounces. This production–consumption gap was met by secondary recovery and from reduction of stocks. Handy & Harman estimated that total worldwide stocks amounted to 366 million ounces.

Canada.—Silver output of Canadian mines increased to an alltime high of 47.0 million ounces of silver in 1972. This was a 2% increase over the 1971 production of 46.0 million ounces and placed Canada again as the leading world producer of silver.

The world's largest single producer of silver, Ecstall Mining Ltd., owned by Texas Gulf Inc., produced 12.8 million ounces of silver in 1972. The silver produced was recovered as byproduct silver in copper, lead, and zinc concentrates from the company's Kidd Creek property, near Timmins, Ontario.

Cominco Ltd., the largest silver producer in British Columbia, derived its output from the lead-zinc-silver ore of its Sullivan mine at Kimberly, British Columbia, and from purchased ores and concentrates. Cominco was also one of Canada's leading producers of refined silver and in 1972 recovered about 5.6 million ounces at its Trail refinery.

Diamond drilling continued at the silver-lead property of Dynasty Exploration Ltd. and Atlas Explorations Ltd. in the Hess Mountain area of the Yukon Territory. Outcrop samples showed good values in silver, lead, and gold.

Agnico–Eagle Mines Ltd. continued an extensive underground development program at its Trout Lake mine in the Cobalt district of northwestern Ontario.

At United Keno Hill Mines Ltd., located near Elsa in the Yukon Territory, production was below that of 1971. In earlier years, this lead-silver-zinc mine was the largest silver producer in Canada. Silver production amounted to 2.5 million ounces compared with 2.9 million ounces in 1971. During the year, the Hector and Calumet mines were idled because of depleted ore reserves; however, potential ore zones were being explored at the nearby Townsite and Dixie properties.

Mill tuneup operations began in August at the 3,000-ton-per-day concentrator of Mattabi Mines Ltd. at its zinc-copper-lead-silver open pit property in the Sturgeon Lake area, 50 miles north of Ignace, Ontario. Ore reserves were reported at 13 million tons grading 7.6% zinc, 0.91% copper, 0.84% lead, and 3.13 ounces of silver per ton.

Dominican Republic.—Gold and Silver reserves on the site of the proposed Pueblo Viejo open pit mine in the Dominican Republic were more than twice what they were thought to be when the project was announced in early 1971, according to New York & Honduras Rosario Mining Co. The project was a joint venture of the New York & Honduras Rosario Mining Co. with J.R. Simplot Co. of Boise, Idaho. The mine was expected to produce 1.5 million ounces of silver and 225,000 ounces of gold per year beginning in 1974. The mine was estimated to have a 20-year reserve at the expected rate of output. Plans were made to construct a cyanide mill to process the ores. Further exploration and studies were to be made of the underlying sulfide zone.

Honduras.—During 1972 the El Mochito mine of the New York & Honduras Rosario Mining Co. supplied 314,476 tons of ore containing 11.72 ounces of silver and 0.009 ounce of gold per ton plus 8.03 lead and 9.37% zinc. The 1972 silver production amounted to 3.4 million ounces, about 3% less than that of 1971.

The exploration and development of the new San Juan ore body was accelerated, resulting in an increase of the reserves by 2.84 million tons. The ore grades 2.6 ounces of silver and 0.002 ounce of gold per ton, 2.68% lead, 6.93% zinc, and 0.32% copper.

Japan.—Mine production of silver in Japan was 10.02 million ounces in 1972, a 11% decrease from the 1971 production. Total consumption rose from 46.0 million ounces in 1971 to 54.4 million ounces in 1972. Refineries produced about 36.1 million ounces of refined silver during 1972. With Peru, Mexico, and Australia as its major suppliers (in that order), Japan imported 16.8 million ounces of silver in refined and unrefined form in 1972. Exports were small, totaling less than 100,000 ounces. Japanese Government stocks of silver were reported to have remained at 16.0 million ounces, unchanged from last year.[5]

Mexico.—Six projects were being explored by two Canadian companies: Tormex Mining Developers and Pure Silver Mines Ltd. (Canada). Possibly the most impressive was the Tormex Industries Peñoles Encantada silver-lead mine in the northern part of the country, 200 miles southeast of Chihuahua. Completion of the 1,000-foot main production shaft was scheduled in 1972. At yearend, proven ore reserves were estimated at 1.5 million tons grading 20 ounces per ton in silver and containing 20% lead. Pure Silver Mines Ltd. (Canada) was also bringing into production three underground mines—the Mother Lode, the Peregrina, and the Cebada—all near Guanajuato, northwest of Mexico City. Total ore reserves were estimated at 4 million tons averaging 11.6 ounces per ton in silver and 0.09 ounce per ton in gold.

The American Smelting & Refining Co. subsidiary, ASARCO Mexicana, S.A., (49% owned by ASARCO) produced 15.5 million ounces of silver during 1972, slightly under the 15.3 million ounces produced in 1971. The mines and plants of ASARCO Mexicana, S.A. operated normally during 1972 with the exception of the Chihuahua lead smelter, which continued to have technical problems. Mine development programs continued during the year. The first phase of the Taxco expansion, consisting of new hoisting and headframe installation, shaft sinking, and preparation of surface sites for the new mill, continued satisfactorily. Ciá. Mexicana de Cobre, S.A. continued studies relating to the financing and development of its La Caridad deposit located near Nacozari in the State of Sonora.

Peru.—Cerro de Pasco Corp. smelting facilities at La Oroya, about 118 miles east of Lima, produced 22,991,000 ounces of silver in 1972 (including silver in exported blister copper), of which 58% was from purchased ores. The Cerro de Pasco Corp., a totally owned subsidiary of Cerro Corp., operated six metal mines and their related concentrators, which were located in the central Andean region of Peru. These mines, the Cerro de Pasco, Cobriza, Yauricocha, San Cristobal, Casapalca, and Morococha, produced silver and other metals. At the Cerro de Pasco mine, which produced lead-zinc-silver ore from both open pit and underground operations, 1.9 million short tons of ore was treated per year. The total silver production refined in 1972 at Cerro's Peruvian operations increased about 20% over that in 1971.

United Kingdom.—Net exports of silver in the first 11 months of 1972 were 67.3 million ounces compared with 3.6 million ounces during the similar period of 1971. The principal destinations were Switzerland, which received 30.1 million ounces; Italy, 15.8 million ounces; West Germany, 12.9 million ounces; France, 11.5 million ounces; East Germany, 4.4 million ounces; Austria, 2.8 million ounces; Belgium, 1.0 million ounces; and 3.3 million ounces were sent to miscellaneous other countries. These unusually large amounts of exports from the United Kingdom resulted in a substantial reduction of stocks held in London. Consumption of silver for industrial purposes in the United Kingdom rose about 10% in 1972 to 27.5 million ounces.

TECHNOLOGY

At Bureau of Mines laboratories, work was conducted on the recovery of precious metals from electronic scrap. The objective was to devise an economical process to recover precious metals and copper from low-grade, complex electronic scrap generated in large quantities by military and civilian electronic operations. A process comprising incineration, caustic leaching to remove aluminum, smelting with siliceous slag, and electrolysis produced 99.9% pure copper metal and anode slimes assaying more than 7,000 ounces per ton of combined precious metals. Silver, gold, and copper recoveries were 93%, 95%, and 87%, respectively. Cost analysis indicated that an alternative process using direct smelting of the scrap to make products for sale to a custom smelter would provide better overall financial returns.[6]

Extraction of silver from silver mill tailings by an electrolytic oxidation procedure

[5] Handy & Harman. The Silver Market, 1972. 57th Annual Rev., 1972, p. 16.

[6] Dannenberg, R. O., J. M. Maurice, and G. M. Potter. Recovery of Precious Metals From Electronic Scrap. BuMines RI 7683, 1972, 19 pp.

was investigated.[7] Resulting silver extraction ranged from 77% to 90%, depending on the tailings treated. Power consumption was 52 to 90 kilowatt-hours per ton for the tailings investigated. Silver and mercury were recovered from leach solutions by precipitation on iron powder, followed by conventional distillation and fire refining.

The Bureau of Mines investigated sweated aluminum electronic scrap to develop methods for recovering the aluminum and for concentrating the other metals, including copper, lead, gold, and silver, into a product that can be separated by known methods.[8] Two molten-salt electrorefining processes were developed and tested. Over 94% of the aluminum was recovered, and the copper, lead, tin, silver, and gold were concentrated threefold in the anode product. The anode product was smelted to prepare a 96% copper bullion containing 690 ounces of silver and 65 ounces of gold with 98% recovery of these values.

A silver with unusual magnetic properties was a promising organic oxidation catalyst.[9] Discovered by researchers at Britain's Reading University, the material was reported to catalyze the ethylene-to-ethylene-oxide reaction with 15% better selectivity than existing commercial initiators while also showing better activity. It also gave encouraging results for oxidation of propylene and possibly was suited for other oxidations. A number of companies were testing the catalyst. The silver was paramagnetic, whereas ordinary silver is diamagnetic. It was produced by decomposing a compound called silver ketenide (C_2Ag_2O). Its catalytic life was being evaluated.

[7] Scheiner, B. J., D. L. Pool, and R. E. Lindstrom. Recovery of Silver and Mercury From Mill Tailings by Electrooxidation. BuMines RI 7660, 1972, 9 pp.

[8] Sullivan, T. A., R. L. de Beauchamp, and E. L. Singleton. Recovery of Aluminum, Base, and Precious Metals From Electronic Scrap. BuMines RI 7617, 1972, 16 pp.

[9] Chemical Engineering. V. 79, No. 25, Nov. 13, 1972, p. 70.

Table 3.—Mine production of recoverable silver in the United States, by month

(Thousand troy ounces)

Month	1971	1972
January	3,744	3,405
February	3,522	3,841
March	4,087	3,934
April	3,483	3,755
May	3,459	3,022
June	3,836	2,948
July	2,866	2,517
August	2,780	2,868
September	3,398	2,746
October	3,451	2,902
November	3,706	2,613
December	3,732	2,682
Total	41,564	37,233

Table 4.—Twenty-five leading silver-producing mines in the United States in 1972, in order of output

Rank	Mine	County and State	Operator	Source of silver
1	Galena	Shoshone, Idaho	American Smelting & Refining Co.	Silver ore.
2	Sunshine	do	Sunshine Mining Co	Do.
3	Luck Friday	do	Hecla Mining Co	Lead ore.
4	Utah Copper	Salt Lake, Utah	Kennecott Copper Corp	Copper, gold-silver ores.
5	Berkeley Pit	Silver Bow, Mont	The Anaconda Company	Copper ore.
6	Bulldog Mountain	Mineral, Colo	Homestake Mining Co	Silver ore.
7	Bunker Hill	Shoshone, Idaho	The Bunker Hill Co	Lead-zinc ore.
8	Crescent	do	do	Silver ore.
9	Burgin	Utah, Utah	Kennecott Copper Corp	Lead-zinc ore.
10	Buick	Iron, Mo	Amax Lead Co. of Missouri.	Lead ore.
11	Pima	Pima, Ariz	Pima Mining Co	Copper ore.
12	Twin Buttes	do	The Anaconda Company	Do.
13	White Pine	Ontonagon, Mich	White Pine Copper Co	Do.
14	Sierrita	Pima, Ariz	Duval Sierrita Corp	Do.
15	Butte Hill Copper Mines.	Silver Bow, Mont	The Anaconda Company	Do.
16	Star Unit	Shoshone, Idaho	The Bunker Hill Co. and Hecla Mining Co.	Lead-zinc ore.
17	Mayflower	Wasatch, Utah	Hecla Mining Co	Copper-lead ore.
18	Idarado	Ouray and San Miguel, Colo.	Idarado Mining Co	Copper-lead-zinc ore.
19	Tyrone	Grant, N. Mex	Phelps Dodge Corp	Copper ore.
20	Copper Queen-Lavender Pit.	Chochise, Ariz	do	Do.
21	San Manuel	Pinal, Ariz	Magma Copper Co	Do.
22	Dayrock	Shoshone, Idaho	Day Mines Inc	Lead ore.
23	Morenci	Greenlee, Ariz	Phelps Dodge Corp	Copper ore.
24	Copper Canyon	Lander, Nev	Duval Corp	Do.
25	Mission Unit	Pima, Ariz	American Smelting & Refining Co.	Do.

Table 5.—Production of silver in the United States in 1972, 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		Gold-silver ore		Silver ore	
		Short tons	Troy ounces of silver	Short tons	Troy ounces of silver	Short tons	Troy ounces of silver
Alaska	288	--	--	--	--	--	--
Arizona	--	--	--	[1] 30,285	[1] 7,079	W	W
California	248	[1] 4,755	[1] 33,926	W	W	--	--
Colorado	164	--	--	--	--	W	W
Idaho	--	--	--	--	--	434,263	8,689,944
Michigan	--	--	--	--	--	--	--
Missouri	--	--	--	--	--	--	--
Montana	--	W	W	[1] 6,273	[1] 41,273	12,953	112,267
Nevada	--	--	--	--	--	159	2,843
New Mexico	--	[1] 45,296	[1] 12,048	--	--	W	W
South Dakota	--	1,466,767	99,992	--	--	--	--
Utah	--	--	--	[1] 143,522	[1] 14,288	W	W
Other States [2]	--	66,461	215,470	--	--	8	655
Total	700	1,583,279	361,436	180,080	62,640	447,383	8,805,709
Percent of total silver	(3)	--	1	--	(3)	--	24

State	Lode—Continued					
	Copper ore		Lead ore		Zinc ore	
	Short tons	Troy ounces of silver	Short tons	Troy ounces of silver	Short tons	Troy ounces of silver
Alaska	--	--	--	--	--	--
Arizona	153,162,632	6,553,533	--	--	--	--
California	--	--	--	--	W	W
Colorado	3,789	3,331	--	--	249,098	119,313
Idaho	19,678	18,648	256,793	3,263,698	--	--
Michigan	8,250,351	785,100	--	--	--	--
Missouri	--	--	8,485,769	1,971,530	--	--
Montana	17,126,668	3,089,647	119	1,637	--	--
Nevada	8,511,860	592,508	--	--	--	--
New Mexico	19,928,805	840,879	--	--	--	--
South Dakota	--	--	--	--	--	--
Utah	W	W	--	--	--	--
Other States [2]	228,955	33,970	--	--	969,358	38,669
Total	207,232,738	11,917,616	8,742,681	5,236,865	1,218,456	157,982
Percent of total silver	--	32	--	14	--	(3)

State	Lode—Continued					
	Copper-lead, lead-zinc, copper-zinc, and copper-lead-zinc ores		Old tailings, etc.		Total	
	Short tons	Troy ounces of silver	Short tons	Troy ounces of silver	Short tons	Troy ounces of silver
Alaska	--	--	--	--	--	288
Arizona	100,172	61,424	83,934	30,764	153,377,023	6,652,800
California	[4] 13,187	[4] 89,828	--	[5] 51,465	17,942	175,467
Colorado	[6] 1,016,367	[6] 3,530,863	7,541	[5] 10,161	1,276,795	3,663,832
Idaho	683,401	2,278,435	--	--	1,394,135	14,250,725
Michigan	--	--	--	--	8,250,351	785,100
Missouri	--	--	--	--	8,485,769	1,971,530
Montana	--	--	55,420	80,228	17,201,433	3,325,052
Nevada	--	--	--	--	8,512,019	595,351
New Mexico	138,273	163,773	181	180	20,112,555	1,016,880
South Dakota	--	--	--	--	1,466,767	99,992
Utah	[4] 35,257,423	[4] 4,285,316	--	--	35,400,945	4,299,604
Other States [2]	2,087,335	103,217	12	4,320	3,352,129	396,301
Total	39,296,158	10,512,856	147,088	177,118	258,847,863	37,232,922
Percent of total silver	--	28	--	1	--	100

W Withheld to avoid disclosing individual company confidential data.
[1] Combined with other dry and siliceous ores to avoid disclosing individual company confidential data.
[2] Includes Illinois, Maine, New York, Oklahoma, Oregon, Tennessee, and Washington.
[3] Less than ½ unit.
[4] Combined with other base metal ores to avoid disclosing individual company confidential data.
[5] Includes byproduct silver recovered from tungsten ore in California and from fluorspar ore in Colorado and Illinois.
[6] Silver combined with copper-lead-zinc ores to avoid disclosing individual company confidential data.

Table 6.—Mine production of recoverable silver in the United States, by State

(Troy ounces)

State	1968	1969	1970	1971	1972
Alaska	3,900	2,030	2,189	868	288
Arizona	4,958,162	6,141,022	7,330,417	6,169,623	6,652,800
California	597,961	491,927	451,150	443,761	175,467
Colorado	1,646,283	2,598,563	2,933,363	3,389,748	3,663,832
Idaho	15,958,715	18,929,697	19,114,829	19,139,575	14,250,725
Maine	[1] 371,745	[1] 319,718	63,227	41,193	16,251
Michigan	472,813	1,009,022	891,579	670,052	785,100
Missouri	340,856	1,442,090	1,816,978	1,660,879	1,971,530
Montana	2,132,571	3,429,314	4,304,326	2,747,557	3,325,052
Nevada	645,192	884,155	718,011	601,470	595,351
New Mexico	224,866	465,591	781,952	782,441	1,016,880
New York	27,615	31,755	23,830	17,928	25,070
Oklahoma	(1)	(1)	[2] 325,887	[2] 362,646	[2] 269,262
Oregon	335	4,749	3,594	3,790	2,252
Pennsylvania	(1)	(1)	(2)	(2)	--
South Dakota	137,668	124,497	119,766	106,785	99,992
Tennessee	89,525	78,614	94,770	131,349	83,466
Utah	5,120,772	5,953,567	6,029,737	5,294,477	4,299,604
Washington	(1)	(1)	(2)	(2)	(2)
Total	32,728,979	41,906,311	45,005,605	41,564,142	37,232,922

[1] Production of Maine, Oklahoma, Pennsylvania, Washington, and Wyoming (1969) combined to avoid disclosing individual company confidential data.

[2] Production of Oklahoma, Pennsylvania (1968–71), Washington, Illinois (1971–72), and North Carolina (1971) combind to avoid disclosing individual company confidential data.

Table 7.—Silver produced in the United States from ore, old tailings, etc., in 1972, 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
Alaska	--	--	--	--	--	--	--	--
Arizona	166,029	165,578	--	--	3,296,309	6,507,572	451	145,228
California	18	15	1,050	--	5,056	135,722	3	38,447
Colorado	1,277	1,269	1,440	--	191,127	3,652,740	8	9,488
Idaho	1,394	1,392	--	--	170,319	14,234,953	2	15,772
Michigan	8,291	8,291	--	--	231,061	785,100	--	--
Missouri	8,486	8,486	--	--	841,174	1,971,530	--	--
Montana	17,201	17,099	--	--	366,990	3,049,841	102	275,211
Nevada	21,336	21,282	--	--	350,804	589,626	54	5,725
New Mexico	20,236	20,127	--	--	702,000	1,004,227	109	12,653
South Dakota	1,467	1,467	--	99,992	--	--	--	--
Utah	36,006	35,846	--	--	852,052	4,096,591	160	203,013
Other States [3]	7,019	7,019	--	--	444,080	393,965	(4)	2,336
Total	288,760	287,871	2,490	99,992	7,450,972	36,421,867	889	707,873

[1] Includes some nonsilver-bearing ore not separable.

[2] Excludes tonnage of fluorspar and tungsten ores from which silver was recovered as a byproduct.

[3] Includes Illinois, Maine, New York, Oklahoma, Oregon, Tennessee, and Washington.

[4] Less than ½ unit.

Table 8.—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 (%)			
	Amalgamation	Cyanidation	Amalgamation	Cyanidation	Smelting [1]	Placers
1968	92,021	53,666	0.28	0.16	99.55	0.01
1969	83,775	49,312	.20	.11	99.68	.01
1970	95,287	24,892	.21	.05	99.73	.01
1971	993	106,785	(2)	.26	99.74	(2)
1972	2,490	99,992	.01	.27	99.72	(2)

[1] Crude ores and concentrates.
[2] Less than ½ unit.

Table 9.—Silver produced at refineries in the United States, by source

(Thousand troy ounces)

Source	1971	1972
Concentrates and ores:		
Domestic	37,242	38,366
Foreign	31,449	39,151
Total	68,691	77,517
Old scrap [1]	30,075	31,090
New scrap	16,524	31,815
Total production	115,290	[2] 140,423

[1] Includes coin bullion purchased from GSA and refined to commercial-grade silver.
[2] Data may not add to total shown because of independent rounding.

Table 10.—U.S. consumption of silver, by end use

(Thousand troy ounces)

Final Use	1971	1972
Electroplated ware	10,909	12,716
Sterling ware [1]	22,729	27,163
Jewelry	3,447	4,870
Photographic materials	36,073	38,251
Dental and medical supplies	1,485	1,991
Mirrors	1,112	1,225
Brazing alloys and solders	12,085	12,214
Electrical and electronic products:		
Batteries	5,631	6,044
Contacts and conductors	27,954	36,434
Bearings	355	344
Catalysts	1,730	3,430
Miscellaneous [1 2]	5,636	6,381
Total net industrial consumption	129,146	151,063
Coinage	2,474	2,284
Total consumption	131,620	153,347

[1] Silver used in commemorative medals estimated at 6.0 million ounces in 1971 and 11.5 million ounces in 1972, distributed partly in sterling ware and partly in miscellaneous.
[2] Includes silver-bearing copper, silver-bearing lead anodes, ceramics, paints, etc.

Table 11.—Value of silver exported from and imported into the United States

(Thousand dollars)

Year	Exports	Imports
1970	49,139	103,757
1971	19,798	82,225
1972	49,260	101,580

Table 12.—U.S. exports of silver in 1972, by country

(Thousand troy ounces and thousand dollars)

Country	Ore and concentrates		Waste and sweepings		Refined bullion	
	Quantity	Value	Quantity	Value	Quantity	Value
Belgium-Luxembourg	10	12	1,517	2,472	1	2
Brazil	--	--	--	--	459	854
Canada	--	--	8	14	916	1,650
Colombia	--	--	--	--	48	77
France	--	--	2	5	4,604	7,350
Germany, West	20	45	648	1,111	3,571	5,497
Greece	--	--	--	--	22	39
Hong Kong	--	--	--	--	(1)	(1)
Israel	--	--	--	--	9	16
Italy	--	--	--	--	338	559
Jamaica	--	--	--	--	1	3
Japan	4	10	4	9	1,598	2,685
Netherlands	--	--	--	--	345	621
Nicaragua	--	--	--	--	1	1
Panama	--	--	--	--	1	1
South Africa, Republic of	(1)	(1)	--	--	--	--
Spain	--	--	17	26	--	--
Sweden	--	--	19	31	--	--
Switzerland	--	--	--	--	4,641	7,028
United Kingdom	17	40	698	1,124	10,135	17,972
Venezuela	--	--	--	--	3	6
Total	51	107	2,913	4,792	26,693	44,361

[1] Less than ½ unit.

Table 13.—U.S. general imports of silver in 1972, 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	14	20	--	--	--	--	903	1,426
Australia	2,780	4,080	--	--	--	--	--	--
Austria	--	--	--	--	--	--	(1)	(1)
Belgium-Luxembourg	--	--	--	--	--	--	165	274
Canada	15,206	24,126	511	833	4,579	7,684	12,481	20,260
Chile	780	298	--	--	--	--	--	--
Colombia	23	36	--	--	--	--	--	--
Germany, West	--	--	--	--	--	--	(1)	(1)
Greece	--	--	2	4	10	16	--	--
Honduras	2,398	2,235	--	--	287	450	2	4
Japan	167	318	--	--	47	71	49	75
Kenya	3	5	--	--	--	--	--	--
Korea, Republic of	--	--	--	--	--	--	82	142
Mexico	1,812	2,644	513	951	--	--	5,193	8,527
Netherlands	--	--	--	--	(1)	(1)	--	--
Nicaragua	73	93	--	--	8	13	--	--
Norway	24	33	--	--	--	--	--	--
Panama	--	--	--	--	--	--	8	14
Peru	9,434	14,444	--	--	--	--	6,787	10,838
Philippines	433	706	--	--	--	--	--	--
South Africa, Republic of	562	857	--	--	--	--	--	--
Switzerland	--	--	--	--	--	--	8	16
United Kingdom	59	84	--	--	--	--	2	3
Venezuela	--	--	1	(1)	--	--	--	--
Total	33,768	49,979	1,027	1,788	4,931	8,234	25,680	41,579

[1] Less than ½ unit.

Table 14.—World production of silver, by country [1]

(Thousand troy ounces)

Country [2]	1970	1971	1972 [p]
North and Central America:			
Canada	44,251	46,024	46,999
El Salvador	154	215	177
Haiti [e]	17	17	17
Honduras	3,816	3,642	3,595
Mexico	42,836	36,657	37,483
Nicaragua	217	261	[e] 275
United States	45,006	41,564	37,233
South America:			
Argentina	2,051	2,050	2,122
Bolivia [3]	6,816	5,369	5,659
Brazil	357	624	319
Chile	2,393	2,729	2,859
Colombia	76	68	70
Ecuador	70	[e] 70	[e] 70
Peru	39,835	38,398	40,188
Europe:			
Austria [4]	176	220	193
Czechoslovakia [e]	1,100	1,100	1,100
Finland	740	623	625
France	2,282	2,109	1,858
Germany, East [e]	4,800	5,000	5,000
Germany, West	[r] 1,800	1,800	1,736
Greece [4]	420	462	--
Hungary [e]	6	6	6
Ireland	2,171	1,432	[e] 1,500
Italy	[r] 1,063	1,236	2,166
Poland [e]	180	200	210
Portugal	[r] 280	264	242
Romania [e]	800	1,000	1,000
Spain [e] [4]	1,640	1,640	1,640
Sweden [5]	3,949	3,895	[e] 3,900
U.S.S.R. [e]	38,000	39,000	40,000
Yugoslavia	3,417	3,354	3,582
Africa:			
Algeria	210	[r] [e] 200	[e] 190
Ghana	5	--	--
Morocco	681	1,698	[e] 1,866
Rhodesia, Southern [6]	70	91	126
South Africa, Republic of	3,527	3,378	3,294
South-West Africa, Territory of [7]	1,229	1,426	[8] 1,111
Tanzania	1	36	52
Tunisia	[r] 56	106	106
Zaire	[r] 1,479	1,470	2,078
Zambia [8]	185	194	109
Asia:			
Burma	[r] 620	685	1,155
China, People's Republic of [e]	800	800	800
India	50	121	142
Indonesia	283	285	279
Japan	[r] 11,030	11,293	10,021
Korea, North [e]	700	700	700
Korea, Republic of	1,494	1,543	1,770
Philippines	1,702	1,940	1,848
Taiwan	96	73	74
Oceania:			
Australia	25,992	21,703	22,796
Fiji	27	[e] 27	24
New Zealand	16	66	31
Papua and New Guinea	[r] 19	19	995
Total	[r] 300,991	288,883	291,391

[e] Estimate. [p] Preliminary. [r] Revised.

[1] Recoverable content of ores and concentrates produced unless otherwise noted.

[2] In addition to the countries listed Bulgaria, Guatemala, Thailand, Turkey, and several other African countries produce silver, but quantities are insignificant or not reported.

[3] Production by the state Mining Company (COMIBOL) plus exports of medium and small (private sector) mines.

[4] Smelter and/or refinery production.

[5] Series revised to indicate mine output; previous data represented metal production.

[6] Output of Inyati mine only.

[7] Recoverable content of Tsumeb Corp. Ltd. concentrates, as reported for year ending June 30 of 1970 and 1971. Data for 1972 represent calendar year production; production of silver for last 6 months of 1971 was 649 thousand troy ounces.

[8] Includes recovery from copper refinery sludges.

Slag—Iron and Steel

By Harold J. Drake [1]

Production of processed iron and steel slag was up 6% in 1972 in contrast to the slight decline that occurred in 1971. The advance was led by a 20% increase in production of steel slag and a 1% increase in output of iron slag. A small rise in output of air-cooled iron-blast-furnace slag, which normally accounts for about 85% of iron slag, was partly offset by declines in output of other types. Increased consumption of iron and steel slag was reported in most of its principal uses.

Prices of iron slag generally were stable in 1972; only slight increases were recorded in principal uses. The average price of all steel slag declined. Imports were off again by 37% whereas export tonnage rose significantly by 27%. Value of exports declined sharply, principally because of sharply reduced shipments of high-value material to Belgium-Luxembourg.

[1] Physical scientist, Division of Nonmetallic Minerals.

Table 1.—Iron-blast-furnace slag 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
1971	20,217	41,203	1,227	1,149	1,787	[1] 2,445	1,581	[1] 4,887	24,812	[1] 49,684
1972	20,968	43,652	910	1,135	1,657	[2] 3,059	1,518	[2] 5,529	25,053	[2] 53,375

[1] Excludes value of slag used for manufacturing hydraulic cement.
[2] Includes value of slag used for manufacturing hydraulic cement.

Source: National Slag Association.

Table 2.—Iron-blast-furnace slag processed in the United States, by States

(Thousand short tons and thousand dollars)

Year and State	Screened air-cooled		All types	
	Quantity	Value	Quantity	Value
1971				
Ohio	4,397	10,209	5,615	12,179
Pennsylvania	4,916	10,681	5,625	12,185
Illinois, Indiana, Michigan	3,737	6,265	4,973	9,145
Other States [2]	7,167	14,048	8,599	16,175
Total	20,217	[1] 41,203	24,812	[1] 49,684
1972				
Ohio	4,235	9,442	5,272	11,794
Pennsylvania	4,967	11,659	5,991	13,497
Illinois, Indiana, Michigan	4,519	8,760	5,351	11,525
Other States [2]	7,247	13,791	8,439	16,559
Total	20,968	43,652	25,053	53,375

[1] Excludes value of slag used for manufacturing hydraulic cement.
[2] Includes, Alabama, California, Colorado, Kentucky, Louisiana, Maryland, Minnesota, New York, Texas, Utah, and West Virginia.

Source: National Slag Association.

Table 3.—Shipments of iron-blast-furnace slag in the United States, by method of transportation

Method of transportation	1971		1972	
	Thousand short tons	Percent of total	Thousand short tons	Percent of total
Rail	4,504	18	4,341	17
Truck	19,845	80	19,952	80
Waterway	463	2	760	3
Total	24,812	100	25,053	100

Source: National Slag Association.

DOMESTIC PRODUCTION

Production of iron and steel slag in 1972 totaled 35.2 million tons valued at $64.4 million. In terms of quantity, production was up 6%. The 8% increase in value was partly accounted for by the inclusion in 1972 of the value of slag used in manufacturing hydraulic cement. Output of iron-blast-furnace slag rose slightly to 25.1 million tons valued at $53.4 million, while that of steel slag totaled 10.2 million tons valued at $11 million.

Screened, air-cooled iron slag in recording a 4% increase in output to 21 million tons valued at $43.7 million, accounted for 84% of the total slag output. Unscreened, air-cooled iron slag, granulated iron slag, and expanded iron slag again recorded declines in output tonnage. The increases in value reported for granulated and expanded slags were due to the inclusion in 1972 of the value of slag used in the manufacture of hydraulic cement.

Production was reported in 16 States; Pennsylvania led, followed by Ohio, Illinois, Indiana, and Michigan. These five States again accounted for two-thirds of domestic output. In 1972, there were 90 plants producing air-cooled slag, 16 producing expanded slag, and 12 producing granulated slag. A total of 1,685 production employees worked 3,757,033 man-hours during the year. The quantity of slag-encrusted magnetic iron recovered at slag plants totaled 3,692,000 tons.

CONSUMPTION AND USES

Construction uses dominated the market for slag in 1972. In the aggregate, use for construction purposes totaled 16.5 million tons valued at $35.6 million, up 8% from

Table 4.—Air-cooled iron-blast-furnace slag sold or used by processors in the United States, by use

(Thousand short tons and thousand dollars)

Use	1971				1972			
	Screened		Unscreened		Screened		Unscreened	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Aggregate in—								
Portland cement concrete construction:								
Structures	1,986	4,385	--	--	1,896	4,503	--	--
Pavements	413	974	--	--	374	793	--	--
Bituminous construction (all types)	4,091	8,445	--	--	4,539	9,503	--	--
Highway and airport construction [1]	7,856	16,117	429	554	8,123	16,945	699	933
Manufacture of concrete block	469	951	--	--	514	1,264	--	--
Railroad ballast	3,174	4,866	--	--	3,686	5,788	5	7
Mineral wool	369	809	42	33	665	1,405	39	30
Roofing slag:								
Cover material	328	1,115	--	--	262	730	--	--
Granules	63	488	--	--	132	953	--	--
Sewage trickling filter medium	36	62	--	--	41	67	--	--
Agricultural slag, liming	8	17	--	--	6	14	--	--
Other uses	1,424	2,974	756	562	730	1,687	167	165
Total	20,217	41,203	1,227	1,149	20,968	43,652	910	1,135

[1] Other than in portland cement concrete and bituminous construction.

Source: National Slag Association.

Table 5.—Granulated and expanded iron-blast-furnace slag sold or used by processors in the United States, by use

(Thousand short tons and thousand dollars)

Use	1971				1972			
	Granulated		Expanded		Granulated		Expanded	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Highway construction and fill (road, etc.)	997	1,547	--	--	988	1,367	--	--
Agricultural slag, liming	74	156	--	--	61	130	--	--
Manufacture of cement (all types)	297	NA	160	NA	444	1,258	226	678
Lightweight concrete	--	--	26	72	--	--	--	--
Aggregate for concrete-block manufacture	96	294	1,351	4,653	23	93	1,264	4,766
Other uses	323	448	44	162	141	211	28	85
Total	1,787	[1] 2,445	1,581	[1] 4,887	1,657	[2] 3,059	1,518	[2] 5,529

NA Not available.

[1] Excludes value of granulated and expanded slag used for hydraulic cement manufacture.

[2] Includes value of granulated and expanded slag used for hydraulic cement manufacture.

Source: National Slag Association.

Table 6.—Steel slag sold or used by processors in the United States, in 1972, by use [1]

(Thousand short tons and thousand dollars)

Use	1971		1972	
	Quantity	Value	Quantity	Value
Railroad ballast	855	1,041	1,327	1,430
Highway base or shoulders	2,635	2,651	3,579	3,512
Paved-area base	1,115	1,150	1,779	1,844
Miscellaneous base or fill	2,053	2,196	1,925	2,193
Bituminous mixes	529	842	563	821
Agricultural	99	630	108	324
Other uses	1,202	1,209	881	899
Total	8,488	9,719	10,162	11,023

[1] Excludes tonnage returned to furnace for charge material.

Source: National Slag Association.

the preceding year. The principal market for air-cooled iron slag, highway and airport construction, expanded about 6%, while the next largest market, bituminous construction, rose 11%. Use in portland cement construction recorded a 5% decline. In nonconstruction uses, railroad ballast recorded a 16% gain, and use in mineral wool, a 71% gain.

Consumption of granulated slag at 1.7 million tons valued at $3.1 million was off 7%, and that of expanded slag at 1.5 million tons valued at $5.5 million was off 4%. The only use of these slags recording an increase in 1972 was that of cement manufacture. The use of granulated slag in highway construction, the principal use, was off slightly. Nearly all expanded slag was used in the manufacture of concrete block, and in 1972, consumption therein was off 6%.

Consumption of steel slag, continuing the trend of recent years, was up as the construction industry continued to use greater quantities. Consumption reached 10.2 million short tons valued at $11 million. Use in highway construction soared 36%, to 3.6 million tons valued at $3.5 million, and use as base material in paved areas was up 60% to 1.8 million tons valued at $1.8 million. Use as railroad ballast rose 55%; miscellaneous base and fill uses declined 6%.

PRICES

The average unit value for all iron-blast-furnace slag in 1972 was $2.13 per ton, nearly the same as in the preceding year. The average unit value for all steel slag fell from $1.14 per ton in 1971 to $1.08 per ton in 1972.

Although sizable changes in unit values occurred by uses, variations in the principal uses were minor, reflecting price controls that existed in 1972. Unit values of bituminous construction and highway and airport construction slags were up 3 cents per ton, portland cement construction slags, 10 cents per ton, and railroad ballast slags, 4 cents per ton.

Due to the inclusion of the value of slags used in the production of hydraulic cement in 1972, price comparisons with 1971 on granulated and expanded slags are not possible. Unit values of steel slags, in general, declined slightly except for many minor uses which rose slightly.

Table 7.—Average value of iron-blast-furnace slag sold or used by processors in the United States, by use

(Per short ton)

Use	Air cooled				Granulated		Expanded	
	Screened		Unscreened					
	1971	1972	1971	1972	1971	1972	1971	1972
Aggregate in—								
Portland cement concrete construction	$2.23	$2.33	--	--	--	--	--	--
Bituminous construction (all types)	2.06	2.09	--	--	--	--	--	--
Highway and airport construction [1]	2.05	2.08	$1.29	$1.33	$1.55	$1.38	--	--
Manufacture of concrete block	2.02	2.46	--	--	3.06	4.00	$3.43	$3.77
Lightweight concrete	--	--	--	--	--	--	3.00	3.03
Railroad ballast	1.53	1.57	--	1.40	--	--	--	--
Mineral wool	2.19	2.11	.78	.77	--	--	--	--
Roofing slag:								
Cover material	3.39	2.78	--	--	--	--	--	--
Granules	7.72	7.24	--	--	--	--	--	--
Sewage trickling filter medium	1.72	1.66	--	--	--	--	--	--
Agricultural slag, liming	2.09	2.03	--	--	2.00	2.13	--	--
Other uses	2.08	2.31	.74	.99	1.38	2.47	2.88	3.00

[1] Other than in portland cement and bituminous construction.

Source: National Slag Association.

FOREIGN TRADE

U.S. exports of iron and steel slag, dross, and scalings in 1972 totaled 27,491 short tons valued at $205,132. Sharp annual fluctuations in tonnage and value of slags exported to Belgium-Luxembourg, Bermuda, Canada, and Colombia, the principal foreign markets for slags, preclude comparisons with preceding years. Imports, all from Canada, totaled 1,455 tons valued at $16,867 compared with 2,324 tons valued at $27,050 in 1971.

Table 8.—U.S. exports and imports for consumption of slag, dross, and scaling from the manufacture of iron and steel

Country	1971		1972	
	Short tons	Value	Short tons	Value
Imports: Canada	2,324	$27,050	1,455	$16,867
Exports:				
Belgium-Luxembourg	4,377	837,611	279	23,375
Bermuda	7,493	22,193	--	--
Brazil	--	--	7	1,159
Canada	9,478	71,806	26,533	95,250
Chile	6	840	--	--
Colombia	173	38,192	1	1,738
France	45	2,700	--	--
Germany, West	--	--	26	9,000
Italy	--	--	22	3,400
Korea, Republic of	40	2,882	--	--
Kuwait	--	--	13	3,436
Mexico	--	--	93	4,749
Nansei Islands	--	--	122	1,110
Netherlands	23	3,080	131	8,680
Taiwan	25	650	--	--
United Kingdom	31	1,965	264	53,235
Venezuela	38	720	--	--
Total	21,729	982,639	27,491	205,132

Sodium and Sodium Compounds

By Charles L. Klingman [1]

Production of sodium compounds from natural sources, trona and dry lakes and well brines, accounted for practically all the increased sodium output in 1972. Soda ash (sodium carbonate) made from natural sources increased 12.3% compared with the output from this source in 1971. On the other hand, soda ash manufactured from salt by the Solvay process increased only 0.6% compared with 1971 output. Salt cake made from brine increased 1.9% compared to an equal decline in output of manufactured sodium sulfate. Several manufacturers of naturally derived sodium compounds completed sizable increases in their production capacity in 1972 and announced plans for further increases through 1975.

Metallic sodium also showed a small increase in production. Most of it was consumed in the manufacture of tetraethyl and tetramethyl lead, compounds used as gasoline additives. Despite proposed stringent standards for air pollution from automotive exhausts, the expected decreases in the use of these compounds failed to materialize.

DOMESTIC PRODUCTION

In 1972 total soda ash production increased 5.3% over that of the previous year as compared with a 2.7% per year average growth rate since 1958. Practically all the 1972 growth occurred in natural soda ash. The portion of the total ash production, which came from natural origins, increased from 40.1% in 1971 to 42.8% in 1972. The average unit value of natural soda ash reported by producers, increased 5.0%, and the total value of the 1972 natural soda ash output increased 18.0% above comparable figures in 1971.

Total sodium sulfate showed no change in output. In a trade-off, the manufactured product declined and the natural product increased 1.9% compared with 1971 figures. The fraction of sodium sulfate derived from natural sources crept up from 50.7% to 51.6% of the total.

Metallic sodium production increased 4.5% over that of 1971 to a total of 159,881 short tons.

[1] Physical scientist, Division of Nonmetallic Minerals.

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]	
	Quantity	Quantity	Value
1968	4,596	2,043	42,104
1969	4,540	2,495	50,922
1970	r 4,393	2,678	56,320
1971	4,275	r 2,865	60,774
1972	p 4,301	3,218	71,689

p Preliminary. r Revised.
[1] Current Industrial Reports, Inorganic Chemicals, U.S. Department of Commerce, Bureau of 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.—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 percent or less)	High purity	Quantity	Value
1968	758	725	700	12,729
1969	730	744	672	12,427
1970	561	r 812	598	10,932
1971	514	843	688	11,008
1972	677	680	701	11,396

p Preliminary. r Revised.
[1] All quantities converted to 100 percent Na_2SO_4 basis.
[2] Current Industrial Reports, Inorganic Chemicals, U.S. Department of Commerce, Bureau of Census.
[3] Includes glauber salt.

In 1972 FMC Corporation added another unit capable of producing 500,000 tons of soda ash per year to its existing facilities at Green River, Wyo. This raised the capacity of this plant to 1.75 million tons per year. Future expansion of 750,000 more tons per year is planned.

Stauffer Chemical Co. also completed a 500,000 ton per year expansion in its Wyoming soda ash production capacity and planned further expansion.

Allied Chemical Corp. was in the process of doubling its production capacity to 1.1 million tons per year and planned to double this figure again by 1974. At present approximately 1,500 people are employed by the three soda ash producers in Green River, Wyo.

A fourth company, Texas Gulf, Inc., announced intention of opening a trona mine and soda ash processing plant in the vicinity of Green River, Wyo. Its planned capacity was 1 million tons per year.

At Searles Lake in California, Kerr-McGee Corp. announced plans for expansion of its present soda ash facilities by 1 million tons per year. Large-scale experimentation with evaporites from Searles Lake was also being conducted by Garrett Research and Development Co., with the intention of opening a new facility for production of soda ash and other chemicals from the lake brine. The plant was expected to be operated by Occidental Petroleum Co.

All three soda ash plants in Green River, Wyo., were cut off from heating gas during a period of prolonged cold weather. Stauffer and FMC obtained permission from the Public Service Commission to build their own pipelines to the Baxter and Bird Canyon Gas Fields so they would be independent of the local gas network which has primary obligations to residences and public buildings.

The final shutdown of the PPG Industries, Inc. Solvay soda ash plant at Barberton, Ohio, was not completed in 1972 as planned because of a temporary high demand for the carbonate. As of the end of 1972 there were six companies operating eight synthetic soda ash plants in five States with a total reported production capacity of 4.65 million tons per year. There are no known plans to close any of these Solvay plants except the PPG plant in Barberton, Ohio.

A list of U.S. producers of natural sodium compounds and metallic sodium is presented in the following tabulation:

Product	Company	Plant Location	State	Source of sodium
Soda ash	Kerr-McGee Chemical Co	Trona	California	Dry lake brine.
Do	Stauffer Chemical Co	do	do	Do.
Do	Allied Chemical Corp	Green River	Wyoming	Underground trona.
Do	FMC Corp	do	do	Do.
Do	Stauffer Chemical Co	do	do	Do.
Sodium sulfate	do	Trona	California	Dry lake brine.
Do	Kerr-McGee Chemical Co	do	do	Do.
Do	U.S. Borax & Chemical Corp	Boron	do	Open pit mining.
Do	Ozark-Mahoning Co	Brownfield	Texas	Subterranean brine.
Do	do	Seagraves	do	Do.
Do	Great Salt Lake Minerals & Chem. Corp	Ogden	Utah	Salt lake brine.
Metallic sodium	E. I. du Pont de Nemours & Co	Niagara Falls	New York	Salt.
Do	do	Memphis	Tennessee	Do.
Do	Ethyl Corp	Baton Rouge	Louisiana	Do.
Do	do	Houston	Texas	Do.
Do	Reactive Metals Inc	Ashtabula	Ohio	Do.

CONSUMPTION AND USES

Nearly half (47%) of the soda ash production in 1972 was consumed in making glass; 25% went to making other chemicals such as sodium bicarbonate; 7% to the pulp and paper industries; 6% to cleaning agents; 3% to water treatment; and the remaining 12% was consumed in miscellaneous uses. Reduction in the use of phosphates in detergents caused a slight increase in soda ash as replacement material.

About 67% of all sodium sulfate production in 1972 went to the making of paper pulp and Kraft paper, but continuing technological changes in the pulp industry may cause a reduction in this usage in the future. About 18% of the sodium sulfate production went to the manufacture of various detergents, and the remaining 15% went to a variety of uses such as glass, stockfeeds, dyes, textiles, and medicines.

The major use for metallic sodium continued to be the manufacture of tetraethyl and tetramethyl lead antiknock compounds for gasoline. About 83% went to this end use in 1972. Four percent of the sodium metal was used to reduce other metals, such as titanium, and the remaining 13% went to miscellaneous uses such as the making of soap and detergents, dyes, explosives, and agricultural chemicals.

The Intergovernmental Relations Subcommittee of the House of Representatives accused the Food and Drug Administration and the U.S. Department of Agriculture of failing to protect the public from excessive use of sodium nitrate and sodium nitrite in meats and other food.[2] Experiments have indicated that the nitrite in food may be chemically converted to nitrosamines, which are known to be potent promoters of cancer in animals and possibly also in human beings.

A lawsuit has also been filed against the Secretary of Agriculture by the Center for Science in the Public Interest, and others, to prohibit the use of nitrates and nitrites in human food. The use of sodium nitrates or sodium nitrites in foods does not constitute a large market, but it is possible that this usage may soon be illegal.

PRICES

Market prices quoted at yearend for sodium carbonate, sodium sulfate, and metallic sodium were as follows:

		1971	1972 [1]
Sodium carbonate (soda ash):			
Light, paper bags, carlots, works	per 100 pounds	$2.35	$2.47½
Light, bulk, carlots, works	do	1.65	1.77½
Dense, paper bags, carlots works	do	2.40–2.45	2.47½
Dense, bulk, carlots, works	do	1.65–1.80	1.77½
Sodium sulfate (100 percent Na_2SO_4):			
Technical detergent, rayon-grade, bags, carlots	per ton	40.00–43.00	43.00–46.00
Technical detergent, rayon-grade, bulk, works	do	33.00–34.00	33.00
Domestic salt cake, bulk, works [2]	do	28.00	28.00
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	.18¾

[1] Chemical Marketing Reporter, current prices of chemicals and related materials. V. 202, No. 26, Dec. 25, 1972, pp. 24–33.
[2] Delivered east of the Mississippi River.

FOREIGN TRADE

In 1972, exports of sodium carbonate increased 10% in tonnage and 23% in value over comparable data for 1971. The fraction of soda ash production exported, however, was 6% which remained about the same as that of the previous year. Canada received 53% of the export; Argentina about 15%; and Venezuela 9%. The remaining 23% was widely distributed to various countries mostly in South America and Asia.

Imports of sodium sulfate increased 12% in tonnage and 15% in value over those of

[2] Chemical and Marketing Reporter. Sodium Nitrate and Nitrite Use in Foods Hit by House Panel. V. 202, No. 8, Aug. 21, 1972, pp. 4–22.

Table 3.—U.S. exports of sodium carbonate and sodium sulfate

(Thousand short tons and thousand dollars)

Year	Sodium carbonate		Sodium sulfate	
	Quantity	Value	Quantity	Value
1970	336	12,007	55	1,668
1971	437	15,400	66	1,825
1972	480	18,914	29	926

1971. Exports of sodium sulfate were less than half of those of 1971. The net imports (imports less exports) amounted to 39% of the total U.S. sodium sulfate consumption. Canada supplied 44% of the sodium sulfate imports, and Belgium-Luxembourg supplied an equal amount. Netherlands, West Germany, and Sweden provided the remainder.

The value of exports of sodium compounds exceeded the value of imports by $14.5 million.

Tariff rates for sodium compounds remained constant throughout the year as shown in the following tabulation:

	Tariff: (dollars per short ton)	
	January 1, 1972	January 1, 1973
Sodium carbonate:		
Calcined (soda ash)	2.40	2.40
Hydrated and sesquicarbonate	2.00	2.00
Sodium sulfate:		
Crude (salt cake)	Free	Free
Anhydrous	.25	.25
Crystallized (glauber salt)	.50	.50

Table 4.—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
1970	243	4,224	26	529	269	4,753
1971	236	4,108	r 32	559	r 268	4,667
1972	226	4,082	73	1,275	299	5,358

r Revised.
[1] Includes glauber salt as follows: 1970 and 1971, none; 1972, 50 long tons ($1,491).

WORLD REVIEW

Argentina.—The Government of Argentina finally approved the building of a Solvay soda ash plant in the Province of Rio Negro.[3] The plant was designed to have a capacity of 220,000 short tons per year and will cost approximately $35 million. The new plant was predicted to produce soda ash for about $62 per short ton. This may be compared to average U.S. production costs of $35 per short ton. There will be a minimal chance of exporting soda ash under such conditions.

Brazil.—In 1971, the government-owned corporation of Brazil, Companhia Nacional de Alcalis, produced 204,000 short tons of synthetic soda ash, which was about 93% of the installed capacity.[4] In 1972 the government contracted the building of additional facilities to increase total soda ash production to about 240,000 short tons per year.[5]

Canada.—A soda ash plant in Amherstburg, Ontario, operated by Allied Chemical Corp., is being expanded from a capacity of 375,000 to 485,000 short tons per year. The construction should be completed by 1975.[6]

Exports of sodium sulfate from Canada increased 7% in tonnage and 5% in value in 1972 as compared to the 1971 export figures.

Germany, West.—Soda ash production in Germany was reported to be 1,486,000 short tons in 1971.[7]

Italy.—Two Italian chemical companies, Orinoco S.p.A. and Ente Minerario Siciliano, joined forces to build a new chemical plant at Termini Imerese, Sicily. It was designed to produce 473,000 short tons per year of both light and dense soda ash by

[3] U.S. Embassy, Buenos Aires, Argentina. State Department Airgram, No. A–74, Feb. 9, 1973, pp. 1–3.
[4] U.S. Embassy, Brazilia, Brazil. State Department Airgram, No. A–84, Nov. 28, 1972, p. 3.
[5] European Chemical News. Plant Summary. V. 22, No. 536, June 9, 1972, p. 30.
[6] European Chemical News. Allied Goes Ahead With Canadian Soda Ash Plan. V. 22, No. 562, Dec. 8, 1972, p. 12.
[7] U.S. Embassy, Duesseldorf, Germany. State Department Airgram, A–90, June 19, 1972, p. 1.

mid-1973. The facility is expected to create 1,100 new jobs.[8]

Sofos S.p.A. (Orinco S.p.A.) is building a new plant in Palermo, Sicily, designed to produce 44,000 short tons per year of sodium and potassium sulfates by 1973.[9]

Spain.—One of the major synthetic soda ash production centers of the world at Torrelavega, Spain, was being increased from 420,000 to 770,000 short tons per year. Expenditures for the expansion was about $12 million.[10]

Sweden.—A soda recovery plant at a pulp mill has been ordered in Bruk, Sweden, to be completed by the end of 1973. The recovery plant features a membrane wall and has a capacity of 564 short tons per day of dry substance.[11]

TECHNOLOGY

A new process for making synthetic soda ash at low cost and without pollution has been described[12] by two scientists from Oak Ridge National Laboratory and the University of California. The proposed system is similar to the traditional Solvay process except that the ammonium chloride produced is reconverted to ammonia by the use of magnesia instead of limestone. The magnesium chloride thus formed is recycled to its original state, magnesia, by heating to about 550° C and in so doing produces hydrogen chloride as a salable byproduct. There is no calcium chloride to be disposed of, and the salt entering the reaction is completely utilized in the process. The developers concede that the proposed process presents little economic threat to soda ash derived from naturally occurring trona; but in Europe, Japan, or other industrial countries the new process may be competitive with the existing Solvay plants.

---

[8] European Chemical News. Plant Summary. V. 22, No. 544, Aug. 4, 1972, p. 19.

[9] Chemical Age. Italian Projects. V. 104, No. 2754, Apr. 28, 1972, p. 528.

[10] European Chemical News. Solvay Expands Spanish Soda Ash Capacity. V. 23, No. 565–566, Jan. 12, 1973, p. 12.

[11] Chemistry and Industry. Soda Recovery Plant for a Swedish Pulp Mill. No. 9, May 6, 1972, p. 351.

[12] Chemical Marketing Reporter. V. 202, No. 24, Dec. 11, 1972, pp. 7 and 34.

Stone

By Harold J. Drake [1]

Production of stone increased 5% from 876 million tons in 1971 to 924 million tons in 1972. Total value increased to a new high of $1.7 billion. Crushed stone accounted for more than 99% of the total volume produced, but its value was only 95% of the total value. Production of crushed stone was 922 million tons valued at $1.6 billion compared with 874 million tons valued at $1.5 billion in 1971. The main uses of crushed stone were dense-graded road-base stone, 23%; concrete aggregate (coarse), 14%; cement manufacture, 12%; unspecified construction aggregate and road stone, 12%; and bituminous aggregate, 9%. Output of dimension stone totaled 1.5 million tons valued at $90.8 million. Dimension stone accounted for less than 1% of total stone output.

Production of stone was reported in all States except Delaware. Pennsylvania, with a total stone production of 67 million tons, was the Nation's leader. Other large producers, in order of output, were Illinois, Florida, Texas, Ohio, and Missouri. These six leading States produced 317 million tons, or 34% of the Nation's output.

Prices of stone generally were stable in 1972; small increases were recorded for some types of stone. The average unit value of all stone increased somewhat. In terms of value, imports were up 29%, whereas exports declined 3%.

Legislation and Government Programs.—The United Steelworkers of America on behalf of workers of the Vermont Marble Co. plant at Rutland, Vt., filed a petition requesting certification of eligibility to apply for adjustment assistance. The request was made under the President's decision of January 28, 1972, pursuant to Sec. 302 (A) (3), of the Trade Expansion Act of 1962, that workers in the domestic marble and travertine industry were eligible to apply for adjustment assistance, under chapter 3, Title III of this act.

The Environmental Protection Agency (EPA) continued to study dust emissions from aggregate-producing facilities and related plants. Dust emission standards are being developed and were expected to be implemented in the not too distant future.

[1] Physical scientist, Division of Nonmetallic Minerals—Mineral Supply.

Table 1.—Salient stone statistics in the United States [1]

(Thousand short tons and thousand dollars)

	1968	1969	1970	1971	1972
Shipped or used by producers:					
Dimension stone	2,060	1,867	1,565	r 1,626	1,490
Value	$98,441	$98,547	$95,157	r $93,132	$90,763
Crushed stone	817,537	861,021	867,628	r 874,497	922,361
Value	$1,219,469	$1,326,047	$1,374,441	r $1,500,933	$1,592,569
Total stone [2]	819,597	826,889	869,193	r 876,123	923,852
Value [2]	$1,317,911	$1,424,594	$1,469,598	r $1,594,065	$1,683,332
Exports (value)	$9,969	$10,223	$10,396	r $11,489	$11,107
Imports for consumption (value)	$24,629	$30,548	$35,674	$33,643	43,472

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

DIMENSION STONE

DOMESTIC PRODUCTION

Production of dimension stone in 1972 decreased about 8% in quantity and 3% in value from the levels of the preceding year. Production totaled 1.5 million tons valued at $90.8 million.

Output of dimension granite in 1972 totaled 621,000 tons valued at $42.6 million, increases of 8% and 11%, respectively, from those of 1971. Production of limestone and dolomite was off 12% in quantity and 5% in value. Production of marble declined to 71,000 tons valued at $16.5 million. Production of sandstone, quartz, and quartzite totaled 231,000 tons valued at $7.7 million compared with 332,000 tons valued at $10.1 million in 1971. Slate production was down 15% from that of 1971.

Domestic production of rough dimension stone totaled 850 thousand tons valued at $23.1 million. Of this quantity, 34% was accounted for by monumental stone, 34% by architectural stone, 28% by construction stone, and 4% by flagging. Less than 1% was accounted for by miscellaneous uses. Production of dressed stone totaled 642,000 tons valued at $67.7 million. About 28% of this was cut and sawed, 20% was curbing, and 17% was house stone veneer. The remainder consisted principally of flagging, monumental, and construction stone. In terms of value, however, the principal dressed stone varieties were cut stone and monumental stone.

CONSUMPTION AND USES

Apparent consumption of dimension stone in 1972 was valued at $125 million, 6% higher than in 1971. Almost all the increase was accounted for by increased imports. Consumption of domestically produced dimension stone in 1972 was lower than in the preceding year. Tonnage of stone used in 1972 compared with 1971 was as follows: granite, up 8%; limestone, down 12%; marble, down 5%; sandstone, down 30%; slate, down 15%; and miscellaneous stone, down 1%.

In terms of value, apparent consumption of granite, which accounted for about two-fifths of total dimension stone consumption in 1972, totaled $52 million, up about 13%. Consumption of marble totaled $32.6 million compared with $30.2 million in 1971. Consumption of limestone, sandstone, and quartzite, in total, was 13% below the levels of 1971.

PRICES

Delivered prices of dimension stone are dependent upon stone variety, finished form, and market location and are not reported to the Bureau of Mines. Average unit values for dimension stone in 1972, as reported to the Bureau of Mines, are as follows, in dollars per ton:

	Building		Monumental, rough and dressed	Flagging
	Rough	Dressed		
Granite	28.01	--	66.85	--
Marble	48.22	259.79	--	--
Limestone	21.28	57.11	--	13.67
Sandstone	12.81	55.14	--	--
Slate	--	174.37	--	31.83
Miscellaneous	13.81	130.78	--	--

FOREIGN TRADE

U.S. exports of dimension stone were valued at $3 million, a level about 22% below that of the preceding year. Approximately one-third of the exports was dolomite, one-half of which was sent to Canada. Nearly all of the remainder was sent to Central and South America. Exports of monumental and building granite were valued at $652,000, nearly all of which was sent to Canada and Japan. Approximately two-thirds of the slate exports consisted of roughly split, squared, or sawed material and one-third consisted of worked slate. Canada again was the principal recipient of this material. Exports of miscellaneous, building, and monumental stone totaled $1.2 million. Canada received 63% of this material; the remainder went principally to Mexico, Japan, Brazil, West Germany, and France.

U.S. imports of dimension stone in 1972 totaled $34.2 million compared to $26.6 million in 1971. Marble accounted for about 47%; granite, 27%; slate, 17%; and travertine, 9%. Imports of marble were valued at $16.1 million, a 27% increase over the level of the preceding year. Imports of granite rose 23% to $9.4 million, and imports of travertine stone were up 12% to $3 million. Imports of slate sharply increased to $5.7 million compared with $3.4 million in 1971. Principal import items were marble slabs and paving tiles valued at $8.4 million, dressed granite articles valued at $7.6 million, slate articles valued at $5.7 million, and dressed travertine valued at $2.8 million. Tonnage of rough blocks of marble and granite was well below that of the preceding year, whereas that of travertine nearly doubled.

Italy and Portugal again supplied the great bulk of the marble and travertine imports. Canada and Italy accounted for most of the imported granite. The remainder was supplied by numerous small countries.

WORLD REVIEW

Argentina.—One of the world's largest deposits of black granite has been reportedly found in Mendoza Province. The granite is said to be of excellent quality and, on the surface, occurs as flagstone, which can be exploited without the need for cutting.

Canada.—Production of dimension stone consists principally of granite, limestone, marble, and sandstone. Approximately 80% of the output is used in construction; the remainder is used as monumental or ornamental stone. Granite, limestone, and marble are used in the form of cut and polished panels in institutional and commercial buildings; limestone and sandstone are used as ashlar in residential buildings.

Portugal.—Portugal continued to be one of the world's largest dimension stone producers. In 1971 total production of dimension stone exceeded 9.4 million short tons, 72% of which was limestone and 19% was granite. The remainder consisted of marble, slate, and miscellaneous stone such as diorite and gabbro. Large volumes of rough stone are exported to Italy where they are processed and eventually reexported.

CRUSHED STONE

DOMESTIC PRODUCTION

Production of crushed stone reached an alltime high of 922 million tons valued at $1.6 billion in 1972. The advance was led by a 7% increase in the output of limestone and dolomite to 671 million tons valued at $1.1 billion and a 14% increase in the output of granite to 106 million tons valued at $183 million. Production of traprock totaled 80 million tons valued at $171 million, an increase of 7% over the levels of 1971. Output of marble was up 37% to 2.2 million tons valued at $25 million. Offsetting the increased production of these kinds of stone were declines in the production of marl, sandstone, shell and other kinds of stone. Output of sandstone decreased 12% to 27 million tons valued at $58 million, output of shell decreased 10% to 17 million tons valued at $30 million, and other stone declined 38% to 14 million tons valued at $24 million. Five States, Florida, Illinois, Ohio, Pennsylvania, and Texas, accounted for one-third of the total production of crushed stone in 1972. With the exception of Illinois each of these States recorded increased output. The largest output was recorded by Pennsylvania, which increased its output 4% to 67 million tons valued at $120 million. In 1972, 14 States accounted for two-thirds of the total production of crushed stone.

Domestic producers during 1972 were concerned with rising labor and maintenance costs accompanied by price controls, depletion of raw material, and pollution control. Control of dust emission was the primary problem, although many companies were also required to treat process water and to reduce noise. It is believed that more than half of the U.S. producers of crushed stone now control dust emissions. Of interest to aggregate producers was the dust-collection system installed by an asphalt producer, Hills Materials Co., Rapid City, S. Dak.[2] A new bag system collector was installed following a cyclone collector used to return coarser dust particles to the mix. The new system collected more than 99% of the fines, which were either returned to the system or sold at an advantageous price. The principal market for the collected fines was as a mineral filler, which contributed to the company's revenues. Of equal importance was the goodwill generated in neighboring residential areas by the complete elimination of airborne dust.

[2] Roads and Streets. Asphalt Plant Solves Dust Problem, Makes Valuable By-product. V. 115, No. 7, July 1972, pp. 97–101.

Anticipated increased demand in the near future led to the expansion of current facilities and the addition of a number of new plants in 1972. General Crushed Stone Co., Easton, Pa., doubled the capacity of its Rockhill quarry located near Quakertown.[3] The company plans to add an automated bituminous concrete plant to the facility. U.S. Steel Corp. recently completed its second year of stone production from its modernized and rehabilitated Calcite Plant at Rogers City, Mich.[4] Increased demand for metallurgical limestone for the company's own needs and to meet expanding growth in chemical and other industrial markets led to the expansion. Principal changes that occurred included expanded screening and crushing capacity and the replacement of stationary stockpiling conveyors with several traveling stackers.

An article described the action of surfactants on water and the action of the combined surfactant and water in dust suppression. Surfactants were used to lower the surface tension of water and thereby increase its ability to agglomerate dust particles to prevent them from becoming airborne.[5]

Depletion of local sand and gravel deposits caused aggregate producers to switch to crushed stone production. One company developed a granite deposit to supply aggregate to its ready-mix concrete operations and to its asphalt plant.[6] The company fortunately was able to use much of the equipment from its discontinued sand and gravel operations. Another granite deposit was also developed to supplement diminishing supplies of gravel.[7] This granite deposit will be used as coarse aggregate to supplement sand and gravel operations that are rich in sand but short on gravel.

A new sandstone quarry in Pennsylvania was in full operation in 1972.[8] The quarry is located at Elysburg, Pa., and produces crushed sandstone for road-base material and ready-mix concrete in the Mt. Carmel-Shamokin area. Another relatively new aggregate producer, Specifications Stone Co., Pana, Ill., has been successful in producing a premium material for a premium market.[9] In operating the limestone quarry, the company has been able to produce a premium material to supply aggregate markets that are more than twice the average shipping distance usually found in the crushed stone aggregates industry.

Staying competitive is a problem faced by most aggregate producers. Companies usually meet the problem by acquiring bigger loaders, trucks, and screens; by using portable plants; by strategically locating stockpiles; and, by using portable overland conveyor systems. Bruening Rock Products, Inc., Decorah, Iowa, used two portable crushing and screening plants and much larger front-end loaders to produce crushed stone from 26 different locations.[10] In addition, the company uses larger haulage trucks to ship farther and faster in order to widen its marketing area.

A large portable, impact crusher mounted on a mobile frame containing a vibratory feeder and diesel engine drive helped another aggregate producer remain competitive.[11] The quarry produced crushed limestone at a rate of more than 600 tons per hour, 24 hours per day to yield six sizes. In order to do so, the crusher unit had to have a very high degree of mobility and a low input of oversize rock. Harrison, Inc., Alcoa, Tenn., operated a granite quarry at Franklin, N.C., using portable aggregate processing equipment with remarkable flexibility in volume of output and in the variety of products produced.[12] Complicating the operation was the fact that no sand existed in the area, thus requiring a sand preparation system to produce sand from crushed granite.

Unusual capacity and product sizing flexibility resulting from a large new portable

---

[3] Rock Products. General Crushed Stone Expands Plant. V. 75, No. 4, April 1972, p. 17.

[4] Herod, B. C. World's Largest Stone Operation Improved in Modernization Program. Pit and Quarry, v. 65, No. 2, August 1972, pp. 76–85.

[5] Minerals Processing. Putting A Wet Blanket On Dust. V. 13, No. 5, May 1972, pp. 4–8.

[6] Trauffer, W. E. Miller Bros. Latest Aggregate Plant. Pit and Quarry, v. 65, No. 5, December 1972, pp. 122–125.

[7] Trauffer, W. E. New 350–TPH Colorado Crushed Stone Plant. Pit and Quarry, v. 64, No. 8, February 1972, pp. 94–96.

[8] Robertson, J. L. Bear Gap—One of Three Pennsy Sandstone Producers. Rock Products, v. 75, No. 10, October 1972, pp. 80–82.

[9] Herod, B. C. Specification Stone-Product Matches Firm's Name. Pit and Quarry, v. 64, No. 12, June 1972, pp. 72–77.

[10] Roads and Streets. Many Short Moves Help Portable Plant Owner Compete. V. 115, No. 3, March 1972, pp. 231, 233, 235.

[11] Roads and Streets. Impact Crusher Ups Quarry Production. V. 115, No. 3, March 1972, p. 235.

[12] Roads and Streets. Tulip Granite Quarry With Portable Equipment. V. 116, No. 1, January 1973, pp. 27–29.

secondary crushing and screening plant gave the Joe Boulanger Construction Co., Fond du Lac, Wis., a strong competitive position.[13] The strategic location of a granite-gneiss aggregates quarry serving a large metropolitan area allowed an asphalt contractor, Tri-County Asphalt Corp., Roseland, N.J., to sharply expand its operation and to diversify into paving and heavy construction.[14] The company used foresight in acquiring its aggregate resource several years before zoning laws, traffic ordinances, and clean air regulations were extended into northern New Jersey thus severely restricting the development of new quarries.

A specially designed suspension span-conveyor system was used to transport crushed stone across a river from the quarry to marketing areas.[15] The deep-trough conveyor was suspended over the river and carried material reduced and dry-screened to specification sizes. Ripping was again proven to be a useful tool for aggregate producers.[16] As a result of instituting a ripping system, production was boosted, costs lowered, and potential trouble with residents in nearby areas was avoided. Ripping costs were less than half the drilling and blasting costs and, since ripping produced better fragmentation, the amount of secondary breakage required was sharply reduced.

CONSUMPTION AND USES

Apparent consumption of crushed stone in 1972 totaled 923 million tons valued at $1.6 billion, an increase of 6% in quantity and value over that of the preceding year. Consumption was higher for most kinds of crushed stone. Compared with the preceding year, limestone and dolomite, which accounted for 73% of the total consumption, rose 7%; traprock, 9% of total consumption, rose 7%; and granite, 12% of total consumption, rose about 14%. Consumption of crushed marble rose 37%. Consumption of sandstone declined about 12%, shell about 10%, calcareous marl about 23%, and miscellaneous stone about 38%.

The principal use for crushed stone of all kinds was as an aggregate in construction, and in paving. Approximately 667 million tons valued at $1.1 million was used for these purposes. The major uses of aggregates were as road-base stone, which rose 10% to 210 million tons valued at $337 million, and concrete aggregate, which dropped 1% to 133 million tons valued at $228 million. Other uses recording production gains were bituminous aggregate, up 4%, and unspecified construction aggregate and road stone, up 17%. Use of crushed stone in the production of cement rose slightly to 109 million tons valued at $130 million, and agricultural purposes declined 16% to 28 million tons valued at $65 million. Stone used in the manufacture of lime declined 1% to 30 million tons valued at $49 million and that used as a flux rose to 26 million tons valued at $45 million.

A two-part series on calcium carbonate —natural chalk whiting, ground limestone, and precipated calcium carbonate—was published. The first part dealt with the different varieties and properties of calcium carbonate fillers (including mining and treatment) and the physical and chemical data of typical calcium carbonate fillers.[17] The second part dealt with patterns of consumption and examined in detail important consuming industries such as paint, putty, rubber, plastics, and paper. In addition, international trade and prices were discussed and an appraisal of future prospects for the calcium carbonate filler-extender industry was given.[18]

PRICES

Quotations in Engineering News-Record for carload lots of 1½-inch crushed stone in 1972, exclusive of discounts, ranged from $6.60 per ton in Los Angeles to $1.60 per ton in Birmingham. The average price reported for 12 major cities was $3.39 per ton. Prices for ¾-inch crushed stone ranged from $1.50 per ton in Minneapolis to $1.65 per ton in Birmingham. The average price for 12 major cities was $3.47 per ton. Prices per ton for industrial fillers and extenders, as reported in the Ameri-

[13] Roads and Streets. Portable Plant Crushes, Grades Road Base With Speed and Precision. V. 115, No. 11, November 1972, pp. 59–60.
[14] Roads and Streets. Strategic Quarry Pays Off for Asphalt Contractor. V. 115, No. 3, March 1972, pp. 222, 223, 226.
[15] Pit and Quarry. New Kansas Crushed Stone Plant. V. 65, No. 5, November 1972, pp. 85–87.
[16] Roads and Streets. Ripping Increases Production and Saves Trouble, Money. V. 115, No. 8, August 1972, pp. 78–79.
[17] Industrial Minerals. Calcium Carbonate: 1. No. 54, March 1972, pp. 9–17.
[18] Industrial Minerals. Calcium-Carbonate: 2. No. 55, April 1972, pp. 9–23.

can Paint Journal, were as follows, in dollars:

Silica, amorphous, ultrafine-ground	69.00
Silica, crystalline	20.50–45.40
Whiting, precipitated surface-treated	48.00
Whiting, dry-ground, 325 mesh	14.25–19.00
Whiting, precipitated, U.S.P	50.00–117.00
Whiting, precipitated, technical	33.00–44.00
Whiting, natural, water-ground	39.00

FOREIGN TRADE

Exports of crushed stone totaled 2.8 million tons valued at $8.1 million in 1972, a slight increase over that of 1971. A decline in exports of crushed limestone was offset by increased exports of other kinds of stone. As in past years, Canada was the principal export market, although some smaller quantities were shipped to other countries in North America.

Imports of crushed stone supplied only a very small share of the U.S. market and in 1972 recorded a 27% increase to 3.2 million tons valued at $4.7 million. Imports of crushed limestone, for use principally in the manufacture of cement, rose 19% to 1.9 million tons valued at $2.6 million; imports of other crushed stone rose 41% to 1.3 million tons valued at $2 million. Imports of dry-ground whiting recorded a modest gain to 20,782 short tons valued at $621,000; imports of precipated chalk whiting rose slightly to 1,895 short tons valued at $150,000.

WORLD REVIEW

Belgium.—Crushed stone production for aggregate use in Belgium in 1971, the latest year for which detailed statistics are available, totaled 31.2 million tons. Approximately 58% of this quantity was accounted for by limestone and 26% by porphyry; the remainder consisted of sandstone and miscellaneous stone. In addition to extensive deposits of igneous rocks in Belgium, local deposits of limestone, quartzite, marble, and sandstone are being worked in many areas.[19] Chalk for use in the cement industry is mined extensively. The largest quarry in Belgium is operated by S. A. Compagnie des Ciments Belges near Tournai. The quarry can produce crushed limestone at a rate of 35,000 tons per day.

Canada.—Capacity of a limestone quarry on Texada Island, northwest of Vancouver, British Columbia, will be more than doubled by a $4 million project scheduled for completion by the early fall of 1973.[20] When completed, the facility will have a capacity of 3.6 million tons of limestone per year, and a 4,000-foot conveyor belt to transfer the crushed stone to ocean-going vessels. A cantilevered swinging boom will be used to load the vessels in any part of the anchorage.

India.—Granite rocks of the Ranikhet area in Uttar Pradesh were described.[21] The study complements previous studies of granitic rocks of the Central Himalayas and is based on field, laboratory, microscopic, and chemical studies.

U.S.S.R.—The Turgoyaksk limestone quarry produced and processed flux stone for use in the Southern Urals metallurgical works. Of the two production systems used, one transports the broken ore by locomotive to the crushing and grading plant and the second uses a 330-ton-per-hour mobile crushing and grading rig. A third system utilizing a large mobile rotary crusher-grader with a capacity of 1,100-tons-per-hour is planned. All three systems make extensive use of belt conveyors.

United Kingdom.—Kingston Mineral, Ltd., Wales, has met environmental responsibilities at its four quarries producing crushed stone.[22] Dust suppression and collection was accomplished by enclosing conveyor systems and installing high-efficiency cyclones and air-treatment plants. Similar pollution control devices were installed at their new coated stone plants. Crushed limestone from the Batts Combe quarry of Amalgamated Roadstone Corp., Ltd. in Somerset will be shipped to the British Steel Corp. Llanwern Steelworks in Monmouthshire, England. Half of the limestone will be used for metallurgical purposes and the other half for making lime.[23]

Amalgamated Roadstone Corp., Ltd., continued exploitation of its granite deposit at Castle-An-Dinas in Cornwall. In-

[19] Fish, B. G. Quarrying in Belgium. Quarry Managers J., v. 56, No. 9, September 1972, pp. 291–300.

[20] Western Miner. Texada West to Double Limestone Plant Capacity. V. 45, No. 11, November 1972, p. 59.

[21] Srivasta, K. S., and A. B. Ulabhaje. Gneissose Granites of the Ranikhate Area in U. P. J. Mines, Metals and Fuels, v. 20, No. 9, September. 1972, pp. 275–280.

[22] Mining and Minerals Engineering. New Coated Stone Plants in North Wales Quarries. V. 8, No. 2, February 1972, p. 36.

[23] Industrial Minerals. No. 64, January 1973, p. 47.

creasing demand for crushed stone to satisfy local, national, and continental markets led the company a few years ago to install new crushing, screening, and coating plants at the quarry. Current plans called for modernizing its mobile equipment, and the acquisition of a fleet of eight-wheeled vehicles for external deliveries. The company maintains a ship-loading facility at Newlyn, which is serviced by a railroad line. In the belief that major export markets can be developed, the company has made a considerable effort to market its crushed granite in West Germany, the Netherlands and France.[24]

TECHNOLOGY

Rock fragmentation from bench blasting was studied by the Federal Bureau of Mines.[25] Eight test blasts were fired in a 2½ foot bench in a limestone formation in a test that was 5% to 10% of full scale and closely proportional to a full-scale bench blast. A study of the largest fragments in a complete screen analysis of each muck pile was used to evaluate the effects of type of pattern, timing of initation, and test location. With a constant burden and stemming, fewer large fragments were produced when the spacing was equal to the burden than with the spacing 1½ times the burden. Overall fragmentation was considerably better with the square pattern than with the rectangular pattern.

The Bureau of Mines also conducted studies of ultra-fine grinding of industrial minerals such as marble, pyrophyllite, talc, mica, and others using the Bureau-developed and patented attrition-grinding process.[26] In statistically designed experimental programs, tests were made to determine large effects of variables such as feed pulp density, grinding medium size, and quantity of electrical energy consumed during grinding. In general, the test results indicated that the best conditions for particle size reduction were approached when grinding with coarser fractions of the sand grinding media, the higher sand-to-mineral weight ratio, and the higher feed pulp density.

A specially designed and built crushing plant was used to supply two major specifications of rock for use in building a dam in California.[27] A 3-mile-long, overland conveyor system was being used in California to supply crushed limestone and shale to a cement mill.[28] A study of the various transportation methods available indicated that the overland conveyor system had the lowest projected operating cost, and the discounted cash flow of savings yielded by the overland system justified the additional incremental capital investment required.

---

[24] The Quarry Managers Journal. Cornish Granite With an Export Potential. V. 56, No. 10, October 1972, pp. 327–336.

[25] Dick, R. A., L. R. Fletcher, and D. V. D'Andrea. A study of Fragmentation from Bench Blasting in Limestone at a Reduced Scale. BuMines R.I. 7704, 1973, 24 pp.

[26] Stanczyk, M. H., and I. L. Feld. Ultrafine Grinding of Several Industrial Minerals by the Attrition Grinding Process. BuMines RI 7641, 1972, 25 pp.

[27] Roads and Streets. Contractor-Plan Crusher Plant Keeps Dam on Schedule. V. 115, No. 8, August 1972, pp. 4–48.

[28] Gasgan, H. L., Jr., and A. C. Lordi. Pacific Cement and Aggregates Movable Rock Crushing Plants and Overland Conveyor System. Pit and Quarry, v. 64, No. 9, March 1972, pp. 90–95.

Table 2.—Stone shipped or used by producers in the United States, by State

(Thousand short tons and thousand dollars)

State	1971		1972	
	Quantity	Value	Quantity	Value
Alabama [1]	17,773	34,413	18,485	42,027
Alaska	2,658	5,066	652	3,012
Arizona	2,873	5,848	4,638	8,018
Arkansas	[r] 17,647	[r] 28,776	16,317	25,020
California	43,336	86,255	37,213	65,811
Colorado	3,785	7,933	4,507	9,599
Connecticut	7,193	15,649	8,719	19,695
Florida	42,816	64,332	[1] 53,093	[1] 81,621
Georgia	30,669	69,897	37,074	82,484
Hawaii [1]	6,056	14,357	5,005	13,494
Idaho	4,149	6,118	3,094	7,042
Illinois [1]	61,991	106,084	56,260	94,225
Indiana	26,233	48,218	27,511	50,919
Iowa	[1] 25,389	[1] 44,977	27,457	48,642
Kansas	[1] 14,908	23,697	[1] 14,547	[1] 23,849
Kentucky [1]	32,514	52,296	34,279	59,690
Louisiana [1]	9,688	14,139	9,190	14,836
Maine	1,133	2,913	1,078	2,996
Maryland	15,912	34,770	19,431	41,973
Massachusetts	7,816	23,582	7,990	23,500
Michigan	40,705	49,240	39,754	50,317
Minnesota	5,838	14,346	5,757	16,318
Mississippi	[r] 726	[r] 709	1,135	1,199
Missouri	41,099	[1] 64,772	42,473	[1] 63,219
Montana	W	W	4,074	5,627
Nebraska	4,174	7,892	4,251	7,645
Nevada	2,531	3,800	3,329	5,926
New Hampshire	429	3,433	528	3,743
New Jersey [1]	13,469	36,057	18,651	53,083
New Mexico	[1] 2,913	[1] 5,337	2,768	5,499
New York	37,778	73,418	38,138	77,825
North Carolina	30,917	58,026	32,297	62,741
North Dakota	W	W	W	W
Ohio	46,891	88,372	48,498	90,821
Oklahoma	19,449	27,125	19,448	26,574
Oregon	13,794	26,708	10,915	18,380
Pennsylvania	64,467	118,469	67,307	124,340
Rhode Island [1]	3	422	329	23
South Carolina	11,047	17,852	12,482	21,819
South Dakota	2,199	8,874	2,665	10,864
Tennessee	32,369	48,665	35,942	55,512
Texas	41,168	[1] 62,144	49,314	[1] 66,573
Utah	2,556	5,335	3,384	6,005
Vermont	[r] 2,496	[r] 27,940	3,300	26,170
Virginia	34,643	63,482	39,987	74,090
Washington	12,436	20,489	14,712	[1] 23,764
West Virginia	9,880	[1] 18,066	[1] 11,649	[1] 21,293
Wisconsin	15,568	25,105	19,394	29,681
Wyoming	2,894	4,789	3,549	5,768
Undistributed	9,145	23,882	1,278	10,058
Total [2]	[r] 876,123	[r] 1,594,065	923,852	1,683,332
Pacific Island Possessions	723	1,726	880	2,397
Puerto Rico	12,130	29,847	13,504	32,792
Virgin Islands	[r] 543	W	726	2,255

[r] Revised. W Withheld to avoid disclosing individual company confidential data; included with "Undistributed" (excluding possessions).

[1] To avoid disclosing individual company data, certain State totals are incomplete; therefore, direct comparisons between output and value data for 1971 and 1972 cannot be made. The portion not included has been combined with "Undistributed." The class of stone omitted from such State totals is noted in the summary chapter of this volume.

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

Table 3.—Stone shipped or used by producers in the United States, by kind

(Thousand short tons and thousand dollars)

Year	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	Granite		Traprock [1]		Marble		Limestone and dolomite		Shell	
1968	70,506	148,333	73,117	125,476	2,559	32,372	603,740	873,634	20,268	28,563
1969	75,880	160,960	78,914	143,230	2,342	34,689	628,937	937,179	19,731	27,983
1970	86,709	183,312	77,227	146,661	1,785	33,734	625,796	961,013	21,713	31,035
1971	r 93,486	r 194,715	75,318	160,582	1,717	34,860	r 628,503	r 1,031,211	18,537	30,088
1972	106,887	225,571	80,473	170,973	2,318	41,545	671,907	1,105,085	16,610	29,571
	Calcareous marl		Sandstone, quartz, and quartzite		Slate		Other stone [2]		Total [3]	
1968	1,211	1,166	27,010	63,416	1,273	14,412	19,914	30,539	819,597	1,317,911
1969	2,490	2,516	27,456	64,272	1,308	13,831	25,831	39,983	862,889	1,424,594
1970	1,739	1,554	24,059	59,185	1,241	13,367	28,925	39,738	869,193	1,469,598
1971	3,459	4,504	30,729	84,630	r 1,232	r 13,615	23,143	39,860	r 876,123	r 1,594,065
1972	2,650	3,598	27,047	65,678	1,595	14,925	14,364	26,886	923,852	1,683,332

r Revised.
[1] Includes gabbro, basalt, diabase, etc.
[2] Includes mica schist, conglomerate, argillite, various light-colored volcanic rocks, serpentine not used as marble, soapstone sold as dimension stone, etc.
[3] Data may not add to totals shown because of independent rounding.

Table 4.—Dimension stone shipped or used by producers in the United States, by use and kind of stone

(Thousands)

Kind of stone and use	1971 Short tons	1971 Cubic feet	1971 Value	1972 Short tons	1972 Cubic feet	1972 Value
GRANITE						
Rough:						
Architectural	60	651	$1,987	46	513	$2,139
Construction [1]	56	687	592	54	652	662
Monumental	194	2,248	11,067	287	2,889	11,266
Other rough stone [2]	(3)	5	27	(3)	5	9
Dressed:						
Cut	W	W	W	W	W	W
Sawed	[4] 11	[4] 128	991	14	156	W
House stone veneer	6	72	492	6	71	132
Construction	18	228	1,425	10	111	636
Monumental	33	385	8,416	33	402	10,125
Curbing	151	1,818	5,579	130	1,537	6,217
Flagging	1	12	W	W	W	W
Paving blocks	W	W	W	W	W	W
Other dressed stone [5]	44	530	7,963	42	505	11,455
Total [6]	575	6,764	38,538	621	6,842	42,641
LIMESTONE AND DOLOMITE						
Rough:						
Architectural	219	2,939	4,681	175	2,400	4,070
Construction [1]	43	526	581	56	706	846
Flagging [7]	17	212	209	18	220	246
Other rough stone [8]	W	W	W	1	18	21
Dressed:						
Cut	59	792	5,558	49	646	5,465
Sawed	38	515	1,755	30	402	1,377
House stone veneer	61	800	1,881	68	894	2,046
Construction	21	259	356	12	145	219
Flagging [9]	2	22	38	2	25	50
Other dressed stone [10]	7	93	65	1	12	38
Total [6]	468	6,159	15,122	411	5,469	14,378
MARBLE						
Rough: Architectural	11	126	480	9	102	434
Dressed:						
Cut	25	285	8,949	21	249	7,908
Sawed	8	90	1,376	5	62	932
House stone veneer				9	104	992
Construction	[11] 32	374	6,799	[11] 27	316	6,275
Monumental						
Total [6]	75	875	17,604	71	833	16,541
SANDSTONE, QUARTZ AND QUARTZITE						
Rough:						
Architectural	34	441	599	42	553	614
Construction [1]	40	504	654	74	973	872
Flagging	W	W	1,739	18	218	894
Other rough stone [4]	W	W	W	1	10	11
Dressed:						
Cut	68	942	3,187	21	273	1,139
Curbing	W	W	W	(3)	5	23
Sawed [12]	50	668	2,227	W	W	W
House stone veneer	W	W	W	27	342	907
Flagging [13]	18	240	689	17	207	472
Other uses not listed [14]	122	r 1,541	r 1,015	32	429	2,752
Total [6]	r 332	r 4,336	r 10,109	231	3,011	7,684
SLATE						
Roofing slate [15]	r 23	--	r 2,055	12	--	1,369
Millstock:						
Structural and sanitary	18	--	3,153	14	--	2,499
Blackboards, etc.[16]	4	--	815	1	--	173
Billiard table tops	W	--	W	4	--	641
Total	22	--	3,968	19	--	3,313
Flagging	37	--	1,047	36	--	1,146
Other uses not listed [17]	13	--	1,511	14	--	1,576
Total [6]	r 94	--	r 8,582	80	--	7,404

See footnotes at end of table.

Table 4.—Dimension stone shipped or used by producers in the United States, by use and kind of stone—Continued

(Thousands)

Kind of stone and use	1971			1972		
	Short tons	Cubic feet	Value	Short tons	Cubic feet	Value
OTHER STONE [18]						
Rough:						
Architectural	6	70	$77	14	166	$142
Construction [1]	30	214	523	43	509	645
Dressed:						
Cut [19]	1	8	117	2	20	219
Construction	W	W	W	4	53	70
Flagging	W	W	154	W	W	W
Structural and sanitary purposes	W	W	W	W	W	W
Total [20]	67	640	2,875	66	783	1,964
TOTAL STONE						
Rough:						
Architectural	331	4,232	7,840	286	3,735	7,411
Construction [1]	183	2,101	2,515	239	2,991	3,172
Monumental	195	2,254	11,083	287	2,891	11,273
Flagging	132	1,666	1,904	36	447	1,169
Other rough stone [21]	3	38	66	2	30	29
Dressed:						
Cut	194	2,524	25,635	117	1,476	20,442
Sawed	81	1,062	5,548	65	845	4,814
House stone veneer	100	1,291	4,044	110	1,424	4,106
Construction	42	523	1,861	32	381	1,706
Roofing (slate) [15]	r 23	--	r 2,055	12	--	1,369
Millstock (slate)	22	--	3,968	19	--	3,313
Monumental	49	571	13,715	65	778	19,511
Curbing	170	2,049	5,991	130	1,543	6,241
Flagging	68	388	2,067	61	300	1,806
Other uses not listed [22]	33	253	4,841	31	220	4,402
Total [22]	r 1,626	r 18,951	r 93,132	1,490	17,061	90,763

r Revised. W Withheld to avoid disclosing individual company confidential data.

1 Includes irregular shaped stone and rubble.

2 Includes flagging and other unspecified rough stone.

3 Less than ½ unit.

4 Includes other uses not specified.

5 Includes figures where symbol W appears to avoid disclosing individual company confidential data. 1972 data also include uses not specified.

6 Data may not add to totals shown because of independent rounding.

7 Data includes small amounts of monumental and other rough stone where symbol W appears.

8 Includes monumental stone and uses not specified (1972 only)

9 Data includes small amount of monumental stone (1971 only).

10 Includes monumental stone (1972) and uses not specified.

11 Data combined to avoid disclosing individual company confidential data; also includes flagging, monumental, rough construction, and uses not specified.

12 1971 data include dressed stone used for house stone veneer and construction.

13 1971 data include stone for curbing.

14 Data include dressed stone used in 1972 for construction, monumental, and structural and sanitary purposes; also, figures where symbol W appears to avoid disclosing confidential data in sandstone, quartz, and quartzite.

15 Includes small amount of slate used for house stone veneer.

16 Includes slate used for electrical purposes and where symbol W appears for slate.

17 Includes slate used for aquarium bottoms, building stone, fireplaces, and flooring.

18 Produced by the following States in 1972, in order of value of output and with number of quarries: Hawaii (4), California (16), New Mexico (3), Maryland (4), Pennsylvania (3), Virginia (1), Oregon (2), and Washington (3).

19 Includes sawed stone and house stone veneer.

20 To avoid disclosing confidential data, figures indicated by symbol W are included in "Total" for "Other stone."

21 Includes small amount of uses not specified.

22 Data includes stone for paving blocks, structural and sanitary purposes (excluding slate), and uses not specified; slate used for aquarium bottoms, building stone, fireplaces, and flooring.

Table 5.—Granite (dimension stone) shipped or used by producers in the United States in 1972, by States

State	Active quarries	Quantity (short tons)	Value (thousands)
California	8	5,429	$329
Connecticut	3	2,769	W
Georgia	30	233,949	6,660
Massachusetts	7	63,013	4,016
Minnesota	14	22,075	W
Missouri	1	2,065	358
Nevada	1	500	10
New York	4	16,455	733
Oklahoma	3	3,399	367
Oregon	2	186	W
South Carolina	6	12,104	497
South Dakota	7	36,673	7,014
Virginia	1	335	6
Washington	1	W	2
Wisconsin	7	8,204	2,112
Other States [1]	37	214,009	20,537
Total	132	621,165	42,641

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes quarries in Colorado (2), Maine (5), Maryland (1), New Hampshire (2), North Carolina (15), Texas (4), Vermont(8).

Table 6.—Limestone and dolomite (dimension stone) shipped or used by producers in the United States in 1972, by State

State	Active quarries [1]	Quantity (short tons)	Value (thousands)
Indiana	17	257,115	$9,532
Iowa	4	9,636	254
Minnesota	4	13,403	1,285
Nebraska	1	420	3
New York	1	500	W
Oklahoma	3	2,083	28
Washington	1	586	15
Wisconsin	27	67,504	1,260
Other States [2]	27	59,818	2,002
Total [3]	85	411,065	14,378
Puerto Rico	[4]	138,594	426

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Count may be duplicated for quarries that produce more than one kind of stone.
[2] Includes quarries in Alabama (1), California (3), Colorado (1), Illinois (2), Kansas (5), Michigan (3), Missouri (1), Ohio (3), Rhode Island (1), Texas (4), and Virginia (3).
[3] Data may not add to totals shown because of independent rounding.
[4] Data not available.

Table 7.—Sandstone, quartz and quartzite (dimension stone) shipped or used by producers in the United States in 1972, by State

State	Active quarries [1]	Quantity (short tons)	Value (thousands)
Arizona	21	7,380	$165
Arkansas	4	8,596	213
California	4	1,082	23
Colorado	20	7,629	155
Connecticut	3	4,740	56
Georgia	1	W	42
Maryland	4	10,653	250
Montana	1	35	1
New York	9	28,978	1,612
Ohio	22	86,715	2,820
Pennsylvania	19	40,876	855
Tennessee	4	9,066	389
Utah	3	W	18
Wisconsin	6	2,290	W
Wyoming	1	308	9
Other States [2]	21	22,344	1,075
Total [3]	143	230,692	7,684

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Count may be duplicated for quarries that produce more than one kind of stone.
[2] Includes quarries in Alabama (1), Idaho (1), Indiana (3), Michigan (1), Minnesota (1), Missouri (1), Nevada (1), New Jersey (2), New Mexico (1), North Carolina (2), South Dakota (2), Virginia (2), Washington (2), and West Virginia (1).
[3] Data may not add to totals shown because of independent rounding.

Table 8.—Crushed and broken stone shipped or used by producers in the United States in 1971 and 1972, by kind of stone and use

(Thousand short tons and thousand dollars)

Kind of stone and use	1971		1972	
	Quantity	Value	Quantity	Value
CALCAREOUS MARL [1]				
Agricultural purposes [2]	217	593	133	166
Cement manufacture	1,821	1,721	[3]2,517	[3]3,431
Other uses [4]	1,420	2,191	--	--
Total [5]	3,459	4,504	2,650	3,598
GRANITE				
Agricultural purposes [6]	W	1,609	W	W
Concrete aggregate (coarse)	19,337	28,945	18,579	31,267
Bituminous aggregate	15,159	29,527	16,088	29,880
Macadam aggregate	3,623	6,601	3,966	6,499
Dense graded road base stone	28,853	49,217	37,877	66,219
Surface treatment aggregate	5,216	9,107	5,696	9,837
Unspecified construction aggregate and roadstone	7,307	11,240	10,048	17,024
Riprap and jetty stone	3,118	5,623	4,036	7,543
Railroad ballast	5,388	8,108	6,162	9,169
Filter stone	133	319	W	W
Fill	165	168	97	88
Other uses [7]	[r]4,612	[r]5,712	3,718	5,403
Total [5]	[r]92,912	[r]156,177	106,266	182,930
LIMESTONE AND DOLOMITE				
Agricultural purposes [6]	[r]32,049	[r]62,422	27,140	58,436
Concrete aggregate (coarse)	96,373	[r]155,817	100,173	167,746
Bituminous aggregate	[r]47,567	[r]83,682	49,977	90,520
Macadam	27,617	43,542	26,993	43,753
Dense graded road base stone	130,515	195,178	139,257	210,832
Surface treatment aggregate	[r]33,999	[r]55,333	38,704	65,799
Unspecified construction aggregate and roadstone	56,570	92,735	71,647	117,731
Riprap and jetty stone	[r]10,999	[r]16,690	12,935	19,725
Railroad ballast	6,153	8,925	7,250	10,913
Filter stone	378	620	339	731
Manufactured fine aggregate (stone sand)	4,507	7,442	4,752	8,662
Terrazzo and exposed aggregate	116	1,366	124	1,433
Cement manufacture	100,770	119,853	101,304	118,199
Lime manufacture	27,361	52,460	28,858	46,818
Dead-burned dolomite	1,565	2,808	1,670	3,029
Ferrosilicon	997	W	1,030	W

See footnotes at end of table.

Table 8.—Crushed and broken stone shipped or used by producers in the United States in 1971 and 1972, by kind of stone and use—Continued

(Thousand short tons and thousand dollars)

Kind os stone and use	1971		1972	
	Quantity	Value	Quantity	Value
LIMESTONE AND DOLOMITE—Continued				
Flux stone	24,234	38,823	24,728	40,422
Refractory stone	949	W	395	1,045
Chemical stone for Alkali Works	3,033	7,226	4,199	9,205
Special uses and products [8]	r 974	r 3,893	876	3,386
Mineral fillers, extenders, and whiting	2,891	21,368	2,984	22,116
Chemicals	W	W	635	1,683
Fill	1,426	1,201	4,243	4,841
Glass	1,452	5,644	1,794	6,827
Sugar refining	W	W	560	2,310
Other uses [9]	15,538	39,060	18,930	34,544
Total [5]	r 628,035	r 1,016,088	671,496	1,090,707
MARBLE				
Agricultural purposes [6]	60	175	44	239
Macadam aggregate	--	--	83	W
Concrete aggregate (coarse)				
Dense graded road base stone				
Unspecified construction aggregate and roadstone	[10] 410	1,380	862	3,826
Riprap and jetty stone				
Filter stone				
Manufactured fine aggregate (stone sand)				
Terrazzo and exposed aggregate	160	2,580	203	3,086
Mineral fillers, extenders, and whiting [11]	1,010	13,121	1,047	17,854
Other uses [12]	W	W	8	W
Total [5]	1,641	17,256	2,247	25,005
SANDSTONE, QUARTZ, AND QUARTZITE [13]				
Concrete aggregate (coarse)	2,790	5,634	2,092	4,061
Bituminous aggregate	2,489	4,385	1,613	3,547
Macadam aggregate	349	457	351	571
Dense graded road base stone	8,017	14,718	8,744	14,216
Surface treatment aggregate	793	2,088	951	1,842
Unspecified construction aggregate and roadstone	3,842	8,197	3,290	5,975
Riprap and jetty stone	1,068	2,791	2,213	4,550
Railroad ballast	610	890	1,014	1,536
Filter stone	17	60	52	84
Manufactured fine aggregate (stone sand)	245	1,010	343	930
Terrazzo and exposed aggregate	56	1,006	23	347
Cement and lime manufacture	610	1,063	522	1,288
Ferrosilicon	294	1,105	227	876
Flux stone	1,333	5,335	1,102	4,149
Refractory stone	255	3,379	211	1,746
Abrasives	42	199	45	W
Glass	967	4,082	925	3,315
Other uses [14]	r 6,621	r 18,122	3,100	8,960
Total [5]	r 30,398	r 74,521	26,817	57,994
SHELL				
Concrete aggregate (coarse)	6,406	8,858	W	W
Dense-graded road-base stone	2,600	2,755	1,675	2,093
Unspecified construction aggregate and roadstone [15]	1,842	3,900	3,281	8,135
Cement and lime manufacture	4,859	7,218	5,675	9,301
Other uses [16]	2,830	7,357	5,980	10,042
Total [5]	18,537	30,088	16,610	29,571
TRAPROCK				
Agricultural purposes	W	W	444	W
Concrete aggregate (coarse)	9,153	25,139	6,643	16,683
Bituminous aggregate	11,282	24,260	11,469	25,434
Macadam aggregate	1,801	3,703	1,438	3,048
Dense graded road base stone	14,478	24,796	19,361	38,380
Surface treatment aggregate	3,956	7,046	5,341	9,430
Unspecified construction aggregate and roadstone	22,234	44,224	23,811	53,024
Riprap and jetty stone	3,056	6,087	3,623	6,644
Railroad ballast	989	1,589	2,332	3,753
Filter stone	87	W	117	287
Manufactured fine aggregate (stone sand)	196	W	231	811
Fill	398	W	1,686	1,018
Other uses [17]	7,673	23,437	3,966	12,311
Total [5]	75,303	160,281	80,462	170,823

See footnotes at end of table.

Table 8.—Crushed and broken stone shipped or used by producers in the United States in 1971 and 1972, by kind of stone and use—Continued

(Thousand short tons and thousand dollars)

Kind of stone and use	1971 Quantity	1971 Value	1972 Quantity	1972 Value
OTHER STONE				
Concrete aggregate (coarse)	1,127	2,703	1,159	2,323
Bituminous aggregate	2,567	5,014	2,202	3,685
Macadam aggregate	203	364	278	W
Dense graded road base stone	4,919	7,706	3,051	5,153
Surface treatment aggregate	818	1,199	591	807
Unspecified construction aggregate and roadstone	5,753	9,651	2,911	5,675
Riprap and jetty stone	3,170	4,914	1,738	2,650
Railroad ballast	1,538	1,287	W	1,072
Mineral fillers, extenders and whiting	W	W	W	W
Fill	W	W	578	741
Other uses [18]	2,981	4,146	1,789	2,317
Total [5]	23,076	36,985	14,298	24,442
TOTAL STONE				
Agricultural purposes [6]	r 33,695	r 69,038	28,393	64,521
Concrete aggregate (coarse)	135,440	227,641	133,471	227,868
Bituminous aggregate	r 79,064	r 146,868	82,560	157,077
Macadam aggregate	33,593	54,666	33,110	54,600
Dense graded road base stone	190,342	296,117	210,013	337,017
Surface treatment aggregate	r 45,437	r 76,164	51,943	89,128
Unspecified construction aggregate and roadstone	96,969	168,624	113,406	202,914
Riprap and jetty stone	r 21,411	r 36,106	24,560	41,187
Railroad ballast	14,678	20,799	18,021	26,443
Filter stone	618	1,320	636	1,353
Manufactured fine aggregate (stone sand)	5,513	10,367	5,869	12,818
Terrazzo and exposed aggregate	337	4,985	402	5,075
Cement manufacture	108,115	129,971	108,857	129,743
Lime manufacture	30,380	56,562	30,051	49,386
Dead-burned dolomite	1,565	2,808	1,670	3,029
Ferrosilicon	1,290	2,899	1,257	2,904
Flux stone	25,567	44,158	25,830	44,571
Refractory stone	1,204	6,745	605	2,792
Chemical stone for alkali works	3,033	7,226	4,199	9,205
Special uses and products [8]	1,017	4,099	1,071	4,389
Mineral fillers, extenders and whiting	r 5,115	r 37,148	4,423	40,587
Fill	3,279	3,351	6,630	6,713
Glass	2,420	9,726	2,718	10,142
Expanded slate	W	W	1,270	5,715
Other uses [19]	34,415	83,545	31,394	63,391
Total [5]	r 874,497	r 1,500,933	922,361	1,592,569

r Revised. W Withheld to avoid disclosing individual company confidential data.

[1] Produced by the following States in 1972, in order of tonnage: South Carolina, Mississippi, Texas, Michigan, Virginia, Indiana, North Carolina, Minnesota, and Nevada.

[2] Includes marl used in agricultural limestone, agricultural marl, and other soil conditioners and nutrients, and minor amounts of filler; 1971 data also include stone used in poultry grit and mineral food.

[3] Data include small amount of fill.

[4] Data include stone used in dense-graded road-base stone, lime manufacture, and uses not specified.

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

[6] Includes agricultural limestone, agricultural marl and other soil conditioners, and poultry grit and mineral food.

[7] Includes stone used in manufactured fine aggregate, terrazzo, cement manufacture, mine dusting (1972), asphalt fill (1972), drain fields, roofing aggregate, chips and granules, waste material (1972), other filler (1971), uses not specified, and any data represented by the symbol W in granite.

[8] Includes stone used for abrasives and mine dusting.

[9] Data include stone used in acid neutralization, building products, paper manufacture, roofing aggregates, chips and granules, waste material (1972), uses not listed in smaller quantities, uses not specified, and any data represented by the symbol W in limestone and dolomite.

[10] Data combined to avoid disclosing confidential data includes surface treatment aggregate (1972).

[11] Includes a minor amount of stone used in roofing aggregates, chips and granules, and any data represented by the symbol W in marble.

[12] Data represent uses not specified.

[13] Includes ground sandstone, quartz and quartzite. Excludes stone used in the manufacture of industrial sand in 1972.

[14] Includes stone used for agricultural purposes, building products, fill, porcelain, pottery and tile, roofing aggregates, chips and granules, uses not listed in small quantities, uses not specified, and any data represented by symbol W in sandstone, quartz and quartzite.

[15] Includes stone used in surface treatment aggregate, and bituminous aggregate (1972).

[16] Includes stone used for agricultural purposes, lime manufacture (1971), asphalt filler (1971), other fillers (1971), uses not specified, and any data represented by the symbol W in shell.

[17] Data include stone used for terrazzo (1972), asphalt and other fillers, drain fields, roofing aggregates, chips and granules, uses not listed in smaller quantities, uses not specified, and any data represented by the symbol W in traprock.

[18] Includes stone used for agricultural purposes, cement manufacture, roofing aggregates, chips and granules, uses not listed in smaller quantities, uses not specified and data represented by the symbol W in other stone.

[19] Data includes stone used in roofing aggregates, chips, and granules, building products, flour (slate), uses not listed in smaller quantities, and uses not specified.

Table 9.—Number and production of crushed-stone quarries in the United States, by size of operation

Annual production (short tons)	1971 Number of quarries	1971 Production Thousand short tons	1971 Production % of total	1972 Number of quarries	1972 Production Thousand short tons	1972 Production % of total
Less than 25,000	1,872	r 15,847	1.8	1,756	14,885	1.6
25,000 to 49,999	597	21,367	2.4	521	18,809	2.0
50,000 to 74,999	341	21,139	2.4	350	21,400	2.3
75,000 to 99,999	233	19,903	2.3	245	21,316	2.3
100,000 to 199,999	r 518	r 75,845	8.7	536	76,667	8.3
200,000 to 299,999	308	76,174	8.7	336	82,870	9.0
300,000 to 399,999	238	82,898	9.5	225	78,252	8.5
400,000 to 499,999	147	65,838	7.5	160	71,911	7.8
500,000 to 599,999	99	53,974	6.2	105	57,761	6.3
600,000 to 699,999	78	50,291	5.8	84	54,051	5.9
700,000 to 799,999	49	36,559	4.2	55	41,030	4.4
800,000 to 899,999	54	45,692	5.2	43	36,578	4.0
900,000 and over	185	r 308,970	35.3	211	346,830	37.6
Total [1]	r 4,719	r 874,497	100.0	4,627	922,361	100.0

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

Table 10.—Crushed stone shipped or used in the United States by method of transportation

Method of transportation	1971 Thousand short tons	1971 % of total	1972 Thousand short tons	1972 % of total
Truck	r 646,937	74	693,108	75
Rail	86,610	10	101,688	11
Waterway	71,154	8	63,156	7
Other	25,340	3	26,620	3
Unspecified	44,455	5	37,791	4
Total [1]	r 874,497	100	922,361	100

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

Table 11.—Granite (crushed and broken stone) shipped or used by producers in the United States in 1972, by State

(Thousand short tons and thousand dollars)

State	Quantity	Value	State	Quantity	Value
Alaska	31	197	South Carolina	9,526	16,009
California	5,337	9,604	Texas	W	416
Georgia	29,668	50,520	Virginia	14,256	25,984
Maine	98	245	Washington	1,242	2,024
New Hampshire	47	45	Wisconsin	1,267	558
New Jersey	2,536	5,484	Wyoming	1,529	W
North Carolina	26,112	46,615	Other States [1]	13,940	24,363
Pennsylvania	348	867			
Rhode Island	329	W	Total [2]	106,266	182,930

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes Alabama, Arizona, Arkansas, Colorado, Connecticut, Idaho, Maryland, Massachusetts, Michigan Minnesota, Missouri, Montana, Nevada, New York, Oregon, and Vermont.
[2] Data may not add to totals shown because of independent rounding.

Table 12.—Traprock (crushed and broken stone) shipped or used by producers in the United States in 1972, by State

(Thousand short tons and thousand dollars)

State	Quantity	Value	State	Quantity	Value
Alaska	221	2,114	New York	2,653	W
Arizona	613	W	Oklahoma	39	W
California	4,068	7,548	Oregon	10,113	16,851
Connecticut	8,233	16,977	Pennsylvania	5,479	11,634
Hawaii	3,596	9,729	Virginia	4,561	9,877
Idaho	1,044	2,260	Washington	11,314	16,521
Massachusetts	4,616	9,898	Wyoming	211	308
Minnesota	97	242	Other States [1]	5,848	21,075
Montana	2,159	1,954			
New Jersey	15,201	42,898	Total [2]	80,462	170,823
New Mexico	397	938	Puerto Rico	799	1,515

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes Maine, Maryland, Michigan, Missouri, New Hampshire, North Carolina, Texas, and Wisconsin.
[2] Data may not add to totals shown because of independent rounding.

Table 13.—Limestone and dolomite (crushed and broken) shipped or used by producers in the United States in 1972, by States and uses

(Thousand short tons and thousand dollars)

State	Agriculture [1]		Aggregates		Riprap		Railroad ballast		Fluxing stone		Miscellaneous and undistributed		Total [2]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Alabama	541	942	9,211	13,727	W	W	W	W	487	1,080	6,066	8,860	16,306	24,610
Arizona	W	W	W	W	--	--	--	--	181	504	2,213	3,090	2,397	3,594
Arkansas	435	1,010	1,831	3,348	(3)	(3)	--	--	W	W	2,923	3,141	5,189	7,498
California	151	947	3,197	4,849	8	W	--	--	W	W	14,702	23,475	18,058	29,270
Colorado	W	W	W	W	W	W	--	--	W	W	3,343	7,217	3,343	7,217
Connecticut	W	W	--	--	--	--	--	--	--	--	202	W	202	W
Florida	1,034	4,273	43,035	65,084	W	W	361	633	--	--	8,663	11,631	53,093	81,621
Georgia	W	W	3,735	6,378	W	W	W	W	--	--	2,396	4,475	6,130	10,853
Hawaii	W	W	449	1,195	--	--	--	--	--	--	780	2,237	1,229	3,431
Idaho	5	53	--	--	--	--	--	--	--	--	W	502	W	555
Illinois	4,024	6,790	43,663	73,991	629	1,069	454	691	779	1,315	6,711	10,369	56,260	94,225
Indiana	1,525	2,828	20,745	32,354	160	290	463	670	W	W	4,086	4,530	26,980	40,672
Iowa	1,876	4,649	19,880	35,919	157	265	W	W	W	W	5,510	7,512	27,422	48,346
Kansas	621	1,051	9,633	17,306	W	W	W	W	--	--	3,708	4,529	13,962	22,886
Kentucky	2,318	3,963	27,973	47,908	1,611	3,518	332	638	--	--	2,045	3,663	34,279	59,690
Maine	W	W	W	W	--	--	--	--	--	--	W	1,986	W	1,986
Maryland	W	W	9,024	18,079	W	W	--	--	W	W	5,429	10,454	14,453	28,532
Massachusetts	180	W	W	W	--	--	--	--	6	39	748	5,407	934	5,447
Michigan	505	624	8,425	11,543	263	359	W	W	11,446	15,944	18,161	18,994	38,800	47,464
Minnesota	231	454	4,261	6,110	40	49	W	W	--	--	293	577	4,825	7,190
Mississippi	W	W	--	--	--	--	--	--	--	--	418	467	418	467
Missouri	4,106	7,547	21,396	34,967	3,688	3,242	W	62	W	W	12,489	14,622	41,679	60,440
Montana	--	--	63	99	W	4	--	--	W	W	1,320	2,299	1,383	2,402

Nebraska	377	1,245	2,500	4,652	W	W	--	--	--	--	1,374	1,745	4,251	7,642
Nevada	W	W	W	149	--	--	--	--	W	W	2,217	W	2,217	W
New Jersey	W	W	W	921	--	--	--	--	W	W	W	W	W	W
New Mexico	--	--	538	964	W	W	--	--	13	W	837	2,036	1,388	3,000
New York	318	1,456	21,347	46,254	598	1,361	189	372	W	W	11,899	16,146	34,350	65,589
North Carolina	5	11	W	W	W	W	--	--	--	--	--	W	W	W
North Dakota	--	--	W	W	--	--	--	--	--	--	W	W	W	W
Ohio	1,469	2,861	28,869	49,010	501	920	973	1,435	3,640	5,925	12,033	25,065	47,484	85,216
Oklahoma	246	445	12,514	17,654	W	W	220	291	--	--	5,055	6,147	18,035	24,537
Oregon	W	W	W	W	--	--	--	--	W	W	W	W	W	W
Pennsylvania	1,100	3,632	33,964	56,628	605	1,222	721	1,400	3,405	7,278	16,688	27,794	56,483	97,953
Rhode Island	W	W	--	--	--	--	--	--	W	W	W	W	W	W
South Carolina	W	W	W	W	W	W	--	--	--	--	W	W	W	W
South Dakota	--	--	853	1,168	W	W	W	W	--	--	832	777	1,685	1,945
Tennessee	2,541	3,913	28,629	42,253	825	1,262	120	W	W	W	3,625	5,868	35,740	53,297
Texas	407	518	29,641	40,038	626	956	632	812	591	825	10,662	12,649	42,559	55,799
Utah	W	W	353	386	W	W	--	--	W	W	1,972	4,027	2,326	4,414
Vermont	W	W	933	1,730	--	--	--	--	--	--	303	3,114	1,235	4,844
Virginia	1,097	2,078	13,193	20,485	182	218	291	392	223	394	4,093	6,525	19,078	30,092
Washington	15	W	43	129	W	4	--	--	W	W	1,041	2,175	1,098	2,308
West Virginia	75	166	5,575	10,202	W	W	644	816	W	W	4,341	7,980	10,636	19,164
Wisconsin	670	1,349	14,451	18,720	211	337	W	W	W	W	467	788	15,799	21,194
Wyoming	2	26	W	676	W	W	W	W	--	--	1,574	1,875	1,576	2,577
Total [2]	25,873	52,882	419,923	684,876	10,104	15,077	5,398	8,212	20,771	33,305	181,222	274,748	663,281	1,067,970
Undistributed	1,266	5,604	6,828	11,505	2,831	4,648	1,852	2,701	3,957	7,116	8,205	21,656	8,214	22,737
Pacific Island Possessions	--	--	880	2,397	--	--	--	--	--	--	--	--	880	2,397
Puerto Rico	--	--	8,047	15,481	--	--	--	--	--	--	2,147	1,552	10,194	17,033

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes agricultural limestone, agricultural marl and other soil conditioners, and poultry grit and mineral food.
[2] Data may not add to totals shown because of independent rounding.
[3] Less than ½ unit.

Table 14.—Shell shipped or used by producers in the United States in 1972, by State

(Thousand short tons and thousand dollars)

State	Quantity	Value
Louisiana	9,190	14,836
Mississippi	152	159
Texas	4,864	7,298
Other States [1]	2,404	7,277
Total [2]	16,610	29,571

[1] Includes Alabama, California, Florida, and Maryland.
[2] Data may not add to totals shown because of independent rounding.

Table 15.—Calcareous marl shipped or used by producers in the United States in 1972, by State

(Thousand short tons and thousand dollars)

State	Quantity	Value
Indiana	26	24
Michigan	79	81
Other States [1]	2,545	3,493
Total	2,650	3,598

[1] Includes Minnesota, Mississippi, Nevada, North Carolina, South Carolina, Texas, and Virginia.

Table 16.—Sandstone, quartz, and quartzite (crushed and broken stone) shipped or used by producers in the United States in 1972, by State

(Thousand short tons and thousand dollars)

State	Quantity	Value	State	Quantity	Value
Alabama	57	160	Pennsylvania	3,565	7,393
Arizona	556	1,440	South Dakota	941	1,897
Arkansas	5,706	8,800	Texas	1,058	2,121
California	5,318	10,744	Utah	151	178
Colorado	215	616	Vermont	51	131
Georgia	83	100	Virginia	736	1,080
Missouri	221	W	Washington	893	2,460
Montana	388	978	West Virginia	1,013	2,129
New Mexico	110	165	Wisconsin	1,143	1,756
New York	714	2,142	Other States [1]	2,728	10,434
North Carolina	64	168			
Ohio	921	2,657	Total [2]	26,817	57,994
Oregon	185	444			

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes Connecticut, Idaho, Kansas, Kentucky, Maryland, Michigan, Minnesota, Nevada, New Hampshire, Oklahoma, Tennessee, and Wyoming.
[2] Data may not add to totals shown because of independent rounding.

Table 17.—Miscellaneous varieties of stone (crushed and broken) shipped or used by producers in the United States in 1972, by State

(Thousand short tons and thousand dollars)

State	Quantity	Value	State	Quantity	Value
Alaska	400	701	Oregon	240	316
California	4,217	7,774	Pennsylvania	1,340	W
Colorado	W	189	Rhode Island	W	23
Hawaii	180	W	Texas	200	W
Indiana	242	538	Washington	148	198
Iowa	25	43	Other States [1]	6,432	14,620
Maine	9	20			
New Mexico	864	W	Total [2]	14,298	24,422
			Puerto Rico	2,367	13,674

W Withheld to avoid disclosing individual company confidential data; included with "Other States."
[1] Includes Arizona, Arkansas, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nevada, New Hampshire, New York, North Carolina, North Dakota, Oklahoma, South Dakota, Utah, Vermont, Virginia, Wisconsin, and Wyoming.
[2] Data may not add to totals shown because of independent rounding.

Table 18.—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	
1970	77	1,454	877	1,755	3,459	388	3,288	1,318
1971	87	1,639	905	r 1,823	r 3,752	585	3,871	1,322
1972	77	1,025	755	1,730	3,802	1,035	4,298	1,227

r Revised.

Table 19.—U.S. imports for consumption of stone and whiting, by class

Class	1971 Quantity	1971 Value (thousands)	1972 Quantity	1972 Value (thousands)
Granite:				
Monumental, paving and building stone:				
Rough ---- cubic feet	706,289	$1,395	498,360	$1,576
Dressed, manufactured ---- do	745,601	6,111	825,697	7,610
Not manufactured and not suitable for monumental, paving or building stone ---- short tons	811	11	1,141	25
Other, n.s.p.f	(1)	132	(1)	179
Total	XX	7,649	XX	9,390
Marble, breccia, and onyx:				
In block, rough or squared ---- cubic feet	29,752	268	25,412	295
Sawed or dressed, over 2 inches thick ---- do	6,660	65	5,347	76
Slabs and paving tiles ---- superficial feet	6,700,271	6,732	8,098,013	8,412
All other manufactures	(1)	5,565	(1)	7,280
Total	XX	12,630	XX	16,063
Travertine stone:				
Rough, unmanufactured ---- cubic feet	3,520	15	7,091	28
Dressed, suitable for monumental, paving and building stone ---- short tons	24,845	2,599	22,928	2,839
Other, n.s.p.f	(1)	52	(1)	110
Total	XX	2,666	XX	2,977
Limestone:				
Monumental, paving, and building stone:				
Rough ---- cubic feet	175	(2)	5,955	4
Dressed, manufactured ---- short tons	1,026	102	3,385	29
Crude, not suitable for monumental, paving or building stone ---- do	19,689	70	21,349	76
Other, n.s.p.f	(1)	26	(1)	24
Total	XX	198	XX	133
Slate:				
Roofing ---- square feet	6,100	1	750	(2)
Other, n.s.p.f	(1)	3,412	(1)	5,679
Total	XX	3,413	XX	5,679
Quartzite ---- short tons	58,612	411	63,886	557
Stone and articles of stone n.s.p.f.:				
Statuary and sculptures	(1)	308	(1)	354
Stone, unmanufactured ---- short tons	7,289	232	29,978	486
Building stone, rough ---- cubic feet	2,790	5	4,220	4
Building stone, dressed ---- short tons	347	33	514	69
Other	(1)	1,764	(1)	2,291
Total	XX	2,342	XX	3,204
Stone, chips, spall, crushed or ground:				
Marble, breccia, and onyx chips ---- short tons	7,923	142	11,590	150
Limestone, chips and spalls, crushed or ground ---- do	1,551,929	2,207	1,850,205	2,567
Stone chips and spalls and stone crushed or ground n.s.p.f ---- do	949,458	1,320	1,335,240	1,976
Slate chips and spalls and slate crushed or ground ---- do	235	2	14	5
Total	2,509,545	3,671	3,197,049	4,698
Whiting:				
Whiting, dry, ground, or bolted ---- short tons	18,017	520	20,782	621
Chalk whiting, precipitated ---- do	1,699	143	1,895	150
Total	19,716	663	22,677	771
Grand total	XX	33,643	XX	43,472

XX Not applicable.
[1] Quantity not reported.
[2] Less than ½ unit.

Sulfur and Pyrites

By Roland W. Merwin [1]

There were significant improvements in conditions in the sulfur industry over those of 1971, with production, shipments, and apparent domestic consumption reaching alltime highs. This was a result of an upsurge in sulfur demand for fertilizer manufacturing and an improvement in export demand. However, the price position remained weak at the lowest level in more than 20 years. This was a result of a continuing worldwide oversupply situation. There were indications at yearend that there might be a moderate improvement in domestic prices in 1973.

Production of Frasch sulfur increased substantially over that of the previous year, and there was an even larger increase in the production of recovered elemental sulfur. There was only a small increase in the production of sulfur in other forms. Shipments of sulfur in all forms by domestic producers increased because of increases in domestic consumption and export demands and a decline in imports. Shipments exceeded production, with the deficit being met by withdrawals from Frasch producers' stocks. The total value of shipments of sulfur in all forms increased from $176.2 million in 1971 to $194.3 million in 1972. However, the average net shipment value f.o.b. mine or plant for Frasch and recovered elemental sulfur, which accounted for 91% of the total shipments of sulfur in all forms in 1972, declined from $17.47 per long ton in 1971 to $17.04 per long ton in 1972.

The United States improved its position as a net exporter of sulfur in all forms. Exports of sulfur were substantially greater than those in 1971 in the face of strong competition and low price levels. There was a decrease in imports of sulfur in all forms. Imports from Canada decreased moderately below those of 1971, mainly because of the phasing out of pyrites imports. Imports from Mexico decreased sharply because of the imposition of duties under the provisions of the Antidumping Act.

[1] Mining engineer, Division of Nonmetallic Minerals.

Table 1.—Salient sulfur statistics

(Thousand long tons, sulfur content)

	1968	1969	1970	1971	1972
United States:					
Production:					
Native	[1] 7,460	7,146	7,082	7,025	7,290
All forms	r 9,735	9,545	9,557	9,580	10,196
Exports, sulfur	1,602	1,551	1,433	1,536	1,852
Imports, pyrites and sulfur	1,754	1,795	1,667	r 1,429	1,188
Stocks Dec. 31: Producer, Frasch and recovered sulfur	r 2,655	r 3,338	r 3,829	r 4,120	3,794
Consumption, apparent, all forms [2]	9,072	9,169	9,227	9,173	9,833
World:					
Production:					
Sulfur, elemental	19,477	20,785	22,162	22,722	25,795
Pyrites	9,591	9,432	10,190	9,870	9,208

r Revised.
[1] Includes 2 thousand tons of sulfur contained in native sulfur ores.
[2] Measured by quantity sold, plus imports, minus exports.

DOMESTIC PRODUCTION

Native Sulfur.—Native sulfur accounted for 72% of the domestic production of sulfur in all forms. All of it was produced from Frasch mines in Texas and Louisiana. No sulfur ore production was reported during the year.

In 1972, 13 Frasch mines produced sulfur; one of these was closed during the year. The producers and mines in Louisiana were Freeport Minerals Co. at Garden Island Bay, Grand Isle, Grand Ecaille, and Lake Pelto; Jefferson Lake Sulphur Co. at Lake Hermitage (closed in March); and Texas Gulf, Inc., at Bully Camp. The producers and mines in Texas were Atlantic Richfield Co. at Fort Stockton; Duval Corp. at Pecos; Jefferson Lake Sulphur Co. at Long Point Dome; and Texas Gulf, Inc., at Boling Dome, Fannett Dome, Moss Bluff Dome, and Spindletop Dome.

Production of domestic Frasch sulfur increased in 1972, being 4% more than that of 1971 and only 2% lower than the all-time peak production in 1968. This was a reflection of a substantial increase in the demand for sulfur in both domestic and foreign markets.

There was a continuing tendency to concentrate production in the larger low-cost mines to counteract the adverse effects of low sulfur prices. During 1969, nine producers operated 21 mines. By yearend 1972, this was reduced to five producers operating 12 mines. Based on the normal production rates prior to closing, these nine closures (two in 1969, five in 1970, one in 1971, and one in 1972) represented an apparent reduction in production potential of slightly more than 1 million tons per year.

The 12 mines remaining in operation at the end of 1972 increased their production over that of 1969 by 1,013,000 tons, or 16%, and over that of 1971 by 369,000 tons, or 5%. Seven of the mines showed increases in production rates over those during 1971, and the other five registered decreases. The five largest mines, with production rates in excess of 1/2 million tons per year each, accounted for 73% of the total Frasch sulfur output for the year. Four medium-size mines, with production rates of more than 250,000 tons per year each, contributed an additional 19% of the year's production. The remaining 8% of the output came from four smaller mines, one of which closed during the year.

Ten mines, operated by the Duval Corp., Freeport Minerals Co., and Texas Gulf, Inc., accounted for most of the production. Only a relatively small portion of the output was obtained from the other two producers, operating three mines. By yearend, this was reduced to two companies with one mine each.

Producers' shipments of Frasch sulfur increased by 13% over those in 1971 as a result of improved demand for domestic consumption and export. The shipments exceed production by 323,000 tons, or 4%, with the shortage being met by withdrawals from producers' stocks. Approximately 76% of the shipments were for domestic consumption and 24% for export.

Table 2.—Production of sulfur and sulfur-containing raw materials by producers in the United States

(Thousand long tons)

	1969		1970		1971		1972	
	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content
Frasch sulfur	7,146	7,146	7,082	7,082	7,025	7,025	7,290	7,290
Recovered elemental sulfur	1,422	r 1,422	1,457	r 1,457	1,595	r 1,595	1,928	1,928
Byproduct sulfuric acid (basis 100%) produced at Cu, Zn, and Pb plants	1,583	517	1,642	537	1,585	518	1,669	546
Pyrites	821	334	845	339	808	316	741	283
Other forms [1]	r 149	r 126	r 161	r 142	r 149	r 126	173	149
Total	--	r 9,545	--	r 9,557	--	r 9,580	--	10,196

r Revised.
[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]
1968	3,203	4,255	7,458	r 6,726	r 271,424
1969	3,289	3,857	7,146	r 6,540	r 173,937
1970	3,446	3,636	7,082	r 6,504	r 153,809
1971	3,408	3,616	7,025	r 6,738	r 117,894
1972	3,755	3,534	7,290	7,613	132,385

r Revised.
[1] Data may not add to totals shown because of independent rounding.
[2] F.o.b. mine.

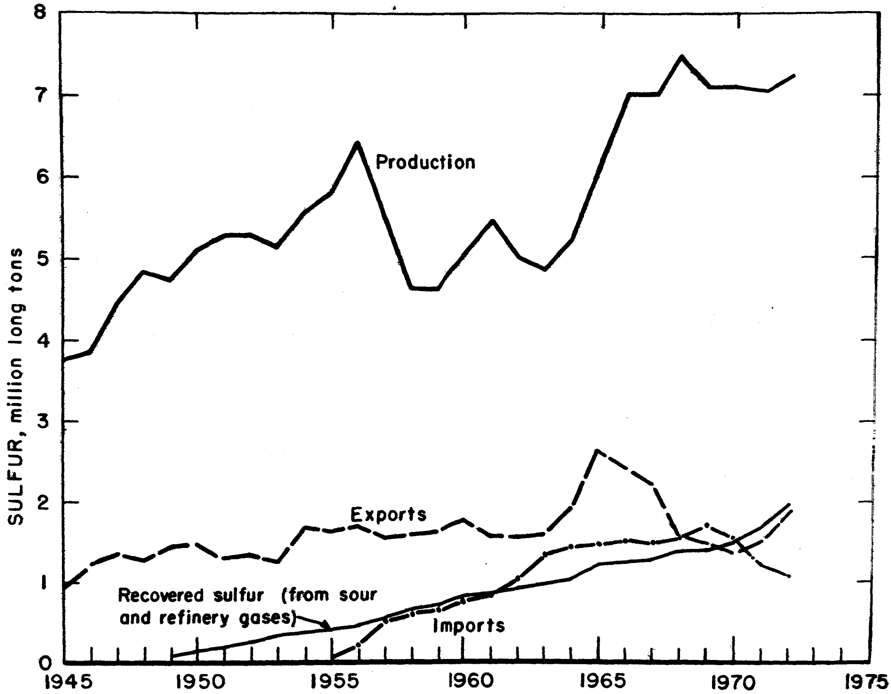

Figure 1.—Domestic Frasch and recovered sulfur production, imports for consumption and exports of native sulfur.

The total value of the shipments, f.o.b. mine, increased by 12%. However, the average reported unit shipment value, f.o.b. mine, was only $17.39 per ton compared with $17.50 per ton in 1971, reflecting a continued weakness in sulfur prices.

Recovered Sulfur.—Elemental recovered sulfur accounted for 19% of the total domestic production of sulfur in all forms. It was produced at 115 plants in 25 States. The 10 largest of these plants accounted for 39% of the total, and the combined production of the five leading States amounted to 74% of the total.

The production was nondiscretionary, as a byproduct from natural gas and petroleum refining operations. As such, it was produced and marketed regardless of demand or price and generally sold in close proximity to the points of production. Approximately 58% was produced at refineries or at satellite plants treating refinery gases, and 42% was produced at natural gas treatment plants.

Production and shipments of this product in 1972 reached alltime highs, with an increase of 21% and 20%, respectively, over those in 1971. However, the total value of the shipments increased by only 8% because of local competitive factors in domestic markets, including competitión from Canadian sources in the northern areas of the Nation. The average reported shipment value, f.o.b. plant, was only $15.63 per ton as compared with $17.37 per ton in 1971, a decrease of 10%.

The five largest recovered sulfur producers were Amoco Production Co., Getty Oil Co., Gulf Oil Corp., Shell Oil Co., and Stauffer Chemical Co. Together, their 33 plants accounted for 49% of recovered sulfur production.

An important development during the year was the emergence of the States of Alabama, Florida, and Mississippi as potential major producers of recovered sulfur. This development was based on the rapidly expanding exploitation of dry sour natural gas and sour natural gas associated with petroleum in the deep Jurassic formations underlying these States. Shell Oil Co.'s Thomasville, Miss., recovered sulfur plant began operating in late July 1972 treating dry sour natural gas. It has a rated capacity of 1,250 tons of sulfur per day and is the largest plant of its kind in the United States. Additionally, several other companies began operating sulfur recovery plants in Alabama and Florida to treat sour natural gas associated with petroleum and condensate. There were plans for the installation of additional sulfur recovery plants in this three-State area with the expectation that recovered sulfur production in this region might increase to approximately 1 million tons per year within the next few years.

Table 4.—Recovered sulfur produced and shipped in the United States

(Thousand long tons and thousand dollars)

Year	Production (gross weight)	Shipments: Gross weight	Shipments: Value [1]
1968	1,359	1,278	49,696
1969	1,422	1,408	41,037
1970	1,457	1,471	30,725
1971	1,595	1,582	27,483
1972	1,928	1,906	29,789

[1] F.o.b. plant.

Table 5.—Recovered sulfur shipped in the United States, by State

(Thousand long tons and thousand dollars)

State	1971		1972	
	Quantity	Value	Quantity	Value
Arkansas	31	579	25	365
California	r 245	5,239	320	5,131
Colorado	2	9	W	W
Florida	4	W	86	W
Illinois and Indiana	96	1,968	134	2,510
Louisiana and Mississippi	34	693	67	1,330
Michigan and Minnesota	60	1,163	60	971
New Jersey	53	1,542	67	1,678
New Mexico	24	294	35	336
New York	4	W	4	W
Oklahoma	1	11	1	9
Pennsylvania	21	438	22	532
Texas	r 776	10,336	847	11,135
Wyoming	41	709	40	W
Other States [1]	189	4,502	199	5,792
Total [2]	r 1,582	27,483	1,906	29,789

r Revised. W Withheld to avoid disclosing individual company confidential data; included with "Other States."

[1] Combined to avoid disclosing individual company confidential data; includes Alabama (1972), Delaware, Kansas, Missouri, Montana, North Dakota, Ohio, and Virginia.

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

Byproduct Sulfuric Acid.—The sulfur contained in byproduct sulfuric acid produced at copper, lead, and zinc roasters and smelters during 1972 amounted to 5% of the total domestic production of sulfur in all forms. It was produced at 15 plants in 11 States. Six acid plants operated in conjunction with copper smelters, and nine plants operated as accessories to lead and zinc roasting and smelting operations. The five largest acid plants accounted for 63% of the output, and the combined production of five States amounted to 84% of the total. The total output was 5% more than that in 1971, and the value of shipments was 8% more than that in 1971.

The five largest producers of byproduct sulfuric acid were American Smelting and Refining Co., The Bunker Hill Co., Kennecott Copper Corp., New Jersey Zinc Co., and St. Joe Minerals Corp. Together, their 10 plants produced 81% of the output during 1972.

Pyrites, Hydrogen Sulfiae, and Sulfur Dioxide.—The contained sulfur in these products accounted for 4% of the total domestic production of sulfur in all forms during 1972. Pyrites was produced at three mines in three States; hydrogen sulfide at five plants in two States; and sulfur dioxide at one plant. Output was 2% less than that in 1971. The value of these combined products was 3% less than that in 1971.

The four largest producers of these products were Phillips Petroleum Co. (hydrogen sulfide), Shell Oil Co. (hydrogen sulfide), Standard Oil Co. of California (hydrogen sulfide), and Cities Service Co. (pyrites and sulfur dioxide). Together, the one mine and five plants accounted for 98% of the contained sulfur produced in the form of these products.

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 [4]	Value
1968	141	289	430	23,228
1969	200	317	517	27,508
1970	218	318	537	23,744
1971	234	284	518	21,293
1972	295	251	546	22,897

[1] Includes acid from foreign materials.
[2] Includes acid produced at a lead smelter in 1968. Excludes acid made from pyrites concentrate in Arizona, Montana, Tennessee, and Utah.
[3] Excludes acid made from native sulfur.
[4] Data may not add to totals shown because of independent rounding.

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
1970	339	142	481	12,214
1971	316	126	442	9,530
1972	283	149	432	9,227

CONSUMPTION

Apparent consumption of sulfur, in all forms, reached an alltime high in 1972. It was 7% more than that of 1971 and 6% more than the previous alltime peak consumption in 1967. This high level of consumption reflected an improvement in demand by the fertilizer industry. There were indications that this condition would continue to improve during 1973.

Sulfur for domestic consumption was obtained mainly from domestic sources: Frasch, 59%; recovered, 19%; and combined byproduct sulfuric acid, pyrites, hydrogen sulfide, and sulfur dioxide, 10%. The remaining 12% of the sulfur was obtained by substantial imports of Frasch and recovered sulfur and by minor imports of pyrites.

Domestic producers of elemental sulfur increased their apparent sales to domestic consumers: Frasch producers by 559,000 tons, or 11% over those in 1971; and recovered sulfur producers by 324,000 tons, or 20%. The reported sale or use of byproduct sulfuric acid, pyrites, hydrogen sulfide, and sulfur dioxide by domestic producers in the domestic market increased by 18,000 tons, or 2%. Imports of elemental sulfur and pyrites for domestic consumption decreased by 241,000 tons, or 17%.

Approximately 90% of the sulfur consumed was in the form of sulfuric acid. The manufacture of fertilizers accounted for approximately 53% of all sulfur consumption. Together, plastic and synthetic products, paper products, paints, nonferrous metals production, and explosives accounted for approximately 20% of demand. The remaining 27% was used for a large number of relatively small individual end uses.

The approximate distribution of consumption was as follows: Southern States, 67%; North Central States, 12%; Western States, 12%; and Northeastern States, 9%.

Table 8.—Apparent consumption of native sulfur in the United States

(Thousand long tons)

	1968	1969	1970	1971	1972
Apparent sales to consumers	r 6,726	r 6,540	r 6,504	r 6,738	7,613
Imports	784	745	539	r 449	269
Total	r 7,510	r 7,285	r 7,043	r 7,187	7,882
Exports:					
Crude	1,549	1,549	1,429	1,532	1,847
Refined	53	2	4	4	5
Total	1,602	1,551	1,433	1,536	1,852
Apparent consumption (sales plus imports minus exports)	r 5,908	r 5,734	r 5,610	r 5,651	6,030

r Revised.

Table 9.—Apparent consumption of sulfur in all forms in the United States [1]

(Thousand long tons)

	1968	1969	1970	1971	1972
Native sulfur	r 5,908	r 5,734	r 5,610	r 5,651	6,030
Recovered sulfur:					
Sales	r 1,278	r 1,408	r 1,471	r 1,582	1,906
Imports	830	r 930	998	850	869
Pyrites:					
Sales	362	334	339	316	283
Imports e	140	120	130	130	50
Smelter acid	430	517	537	518	546
Other forms [2]	124	126	142	126	149
Total	r 9,072	r 9,169	r 9,227	r 9,173	9,833

e Estimated. r Revised.

[1] Crude sulfur or sulfur content.

[2] Includes consumption of hydrogen sulfide and liquid sulfur dioxide.

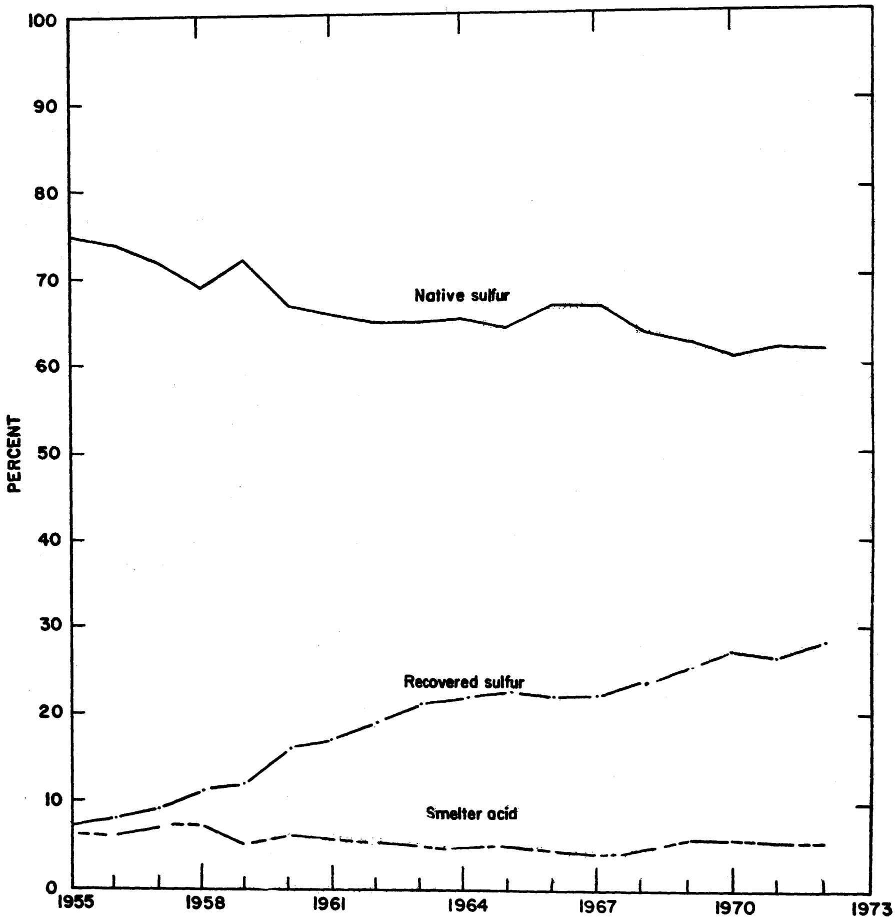

Figure 2.—Sulfur supply sources as a percent of total apparent consumption based on sulfur content.

STOCKS

Yearend producers' stocks of combined Frasch and recovered sulfur were 8% less than those at yearend 1971 because of withdrawals from Frasch stocks to meet a demand that exceeded production. This was the first reduction in producers' stocks since 1967. The combined yearend stocks amounted to approximately a 5-month supply, based on the 1972 domestic and export demands for domestically produced Frasch and recovered sulfur.

Table 10.—Producers' yearend stocks

(Thousand long tons)

Year	Frasch	Recovered	Total
1968	2,576	79	2,655
1969	3,243	95	3,338
1970	3,744	85	3,829
1971	4,023	97	4,120
1972	3,665	129	3,794

PRICES

Producers of Frasch and recovered elemental sulfur report the value of their shipments f.o.b. mine or plant. Such values vary widely between different mines or plants, depending upon prevailing selling prices in the markets they individually serve and the transportation costs to these markets.

The values f.o.b. mine or plant do not necessarily reflect the ultimate selling prices because most sales of elemental sulfur, generally in the form of molten sulfur, are made ex-terminal near the points of consumption. Due to the highly competitive nature of the transactions, prices are not generally made available. The trade journal, Sulphur, reported bimonthly on sales prices by areas on the basis of the best information available.

In general, prices remained relatively stable throughout the year in those major consuming areas served by the Frasch industry. However, prices weakened throughout the year in those consuming areas primarily served by producers of recovered sulfur.

Early in 1972, several major sulfur producers independently announced increases in the price of liquid sulfur ex-terminals, ranging upwards to about $3 per ton in the Tampa, Fla., area to be effective March 1, 1972, or as soon thereafter as contractual agreements permitted. Shortly thereafter, however, these increases were rescinded because of nonacceptance by major consumers under the terms of prevailing meet or release contracts. By the end of 1972, an increasingly strong demand for sulfur by fertilizer manufacturers had created a situation in which sulfur was in short supply in the major fertilizer manufacturing areas. It became evident that this situation, coupled with the increasing cost of producing Frasch sulfur, would lead to price increases in Tampa, Fla., and other fertilizer centers in early 1973.

Table 11.—Reported sales values of shipments of elemental sulfur, f.o.b. mine or plant

(Dollars per long ton)

Year	Frasch	Recovered	Total
1968	40.35	38.89	40.12
1969	26.60	29.15	27.05
1970	23.65	20.89	23.14
1971	17.50	17.37	17.47
1972	17.39	15.63	17.04

Source: Producers' Reports.

Table 12.—Sulfur prices, liquid, ex-terminal

(Dollars per long ton)

	Yearend 1971	Yearend 1972
Gulf Coast region	23–26	24–25
Tampa, Fla	24–25	25
South Atlantic region	27–28	27–28
North Atlantic region	29–30	29–30
North Central States	24–25	24–25

Source: Sulphur (London).

FOREIGN TRADE

The United States improved its position as a net exporter of sulfur. Exports of sulfur in all forms in 1972 were 21% more than those in 1971, and imports in all forms were 17% less than those in 1971. In 1972, exports of elemental and processed sulfur exceeded imports of elemental sulfur and sulfur contained in pyrites by 664,000 long tons. In 1971, exports of sulfur in these forms exceeded imports by only 107,000 tons. The improvements in the export-import balance reflected strenuous efforts on the part of domestic producers to maintain their competitive position in both domestic and world markets in the face of strong foreign competition and low price levels. Favorable factors included the devaluation of the U.S. dollar, the imposition of countervailing duties on elemental sulfur imports from Mexico under provisions of the Antidumping Act, and logistic problems limiting sulfur exports from Canada to world markets other than the United States.

Exports were almost entirely in the form of elemental Frasch sulfur. The tonnage of elemental sulfur exported during 1972 was 21% greater than in 1971. However, the total value increased by only 16%, with the average reported value of $18.17 per ton in 1971 declining to $17.55 per ton in 1972. Together, Belgium and the Netherlands received 62% of these exports, mainly for transshipment to other European Economic Community (EEC) countries. Brazil, with 12%, was the third largest customer.

Imports of sulfur consisted largely of recovered sulfur from Canada and Frasch sulfur from Mexico. Imports from Canada in 1972 were 2% more than those in 1971. However, imports from Mexico were 40% less than those in 1971, primarily because of the imposition of antidumping duties. The total quantity of elemental sulfur imported was 12% less than that in 1971, and the total value decreased by 36%. The average declared customs value in 1972 was $14.32 per ton, whereas in 1971 the average was $19.57 per ton.

Estimated imports of pyrites from Canada in 1972 were 100,000 tons, containing 50,000 tons of sulfur, or only 38% of those in 1971. (Bureau of Census data do not include all shipments.) Imports of pyrites were phased out in 1972 because this product was no longer competitive with low-cost domestic elemental sulfur.

Acting under the provisions of the Antidumping Act, the U.S. Government completed an ongoing investigation of the sales of Mexican elemental sulfur within the United States and initiated a similar investigation relating to the importation of Canadian sulfur.

On February 3, 1972, the U.S. Department of the Treasury announced its determination that elemental sulfur from Mexico was being, or was likely to be, sold in the U.S. market at less than fair value within the meaning of the Antidumping Act.[2] On February 9, 1972, the U.S. Tariff Commission announced that having received this advice from the Department of the Treasury on sulfur imports from Mexico, it was instituting an investigation to determine whether an industry in the United States was being, or was likely to be, injured or prevented from being established by reason of these imports.[3]

The Tariff Commission on May 4, 1972, announced that it had unanimously determined that an industry in the United States was being injured by reason of the importation of elemental sulfur from Mexico at less than fair value.[4] On June 26, 1972, the Department of the Treasury announced that it was adding elemental sulfur from Mexico to the list of findings of dumping currently in effect.[5] This action made sulfur imports from Mexico subject to duties retroactive to the date of the prior Withholding of Appraisement notice on November 2, 1971.

On February 17, 1972, the Bureau of Customs, Department of the Treasury, announced that it had completed a summary investigation of information it had received that tended to indicate that elemental sulfur and nonelemental sulfur produced in Canada was being sold for exportation to the United States at less than the prices for home consumption or the cost of production. Therefore, the Bureau of Customs was initiating an inquiry to determine if there was a fact or likelihood that such sales were, or were likely to be, at less than fair value within the meaning of the Antidumping Act.[6] On April 13, 1972, the Bureau of Customs announced that its investigation of sulfur imports from Canada was being limited to elemental sulfur.[7]

On May 3, 1972, the Bureau of Customs, announced that it was undertaking a review of the extent to which price information relating to sales below cost of production might be used in determining fair value within the meaning of the Antidumping Act.[8] Although not so stated, it appeared that this review would relate to the ongoing investigation of sales of Canadian sulfur in the United States because the main basis of the complaint upon which the sulfur investigation was initiated was to the effect that sales of Canadian sulfur were being made at less than cost of production. The investigation of Canadian sulfur sales in the United States was continuing at yearend.

---

[2] U.S. Department of the Treasury. Elemental Sulphur From Mexico. Determination of Sales at Less Than Fair Value. Federal Register, v. 37, No. 25, Feb. 5, 1972, p. 2793.

[3] U.S. Tariff Commission. Elemental Sulphur From Mexico. Notice of Investigation and Hearing. Federal Register, v. 37, No. 30, Feb. 12, 1972, pp. 3212–3213.

[4] U.S. Tariff Commission. Elemental Sulfur From Mexico. Determination of Injury. Federal Register, v. 37, No. 91, May 10, 1972, pp. 9417–9420.

[5] U.S. Department of the Treasury, Bureau of Customs. Antidumping. Elemental Sulphur From Mexico. Federal Register, v. 37, No. 125, June 28, 1972, p. 12727.

[6] U.S. Department of the Treasury, Bureau of Customs. Sulphur From Canada. Antidumping Proceeding Notice. Federal Register, v. 37, No. 37, Feb. 24, 1972, p. 3922.

[7] U.S. Department of the Treasury, Bureau of Customs. Sulphur From Canada. Amendment of Antidumping Proceeding Notice. Federal Register, v. 37, No. 76, Apr. 19, 1972, pp. 7717–7718.

[8] U.S. Department of the Treasury, Bureau of Customs. Antidumping: Fair Value Determinations. Sales Below Cost of Production; Solicitation of Views. Federal Register, v. 37, No. 88, May 5, 1972, p. 9125.

Table 13.—U.S. exports and imports for consumption of sulfur

(Thousand long tons and thousand dollars)

Year	Exports: Elemental Frasch or sulfur recovered by any process		Exports: Processed, ground, screened, refined, sublimed, precipitated, colloidal, rolled flowers, and insoluble		Imports	
	Quantity	Value	Quantity	Value	Quantity	Value
1970	1,429	33,096	4	955	1,537	34,149
1971	1,532	27,844	4	1,019	r 1,299	25,419
1972	1,847	32,409	5	1,278	1,138	16,288

r Revised.

Table 14.—U.S. exports of sulfur, by country

Destination	Elemental, Frasch or sulfur recovered by any process: 1971		1972		Processed, ground, screened, refined, sublimed, precipitated, colloidal, rolled flowers, and insoluble: 1971		1972	
	Long tons	Value (thousands)	Long tons	Value (thousands)	Long tons	Value (thousands)	Long tons	Value (thousands)
Argentina	8,906	$171	50,618	$962	38	$18	130	$64
Australia	60,897	1,410	96,482	2,126	399	58	405	167
Belgium-Luxembourg	352,677	5,287	575,535	7,832	26	3	43	5
Brazil	213,929	4,161	229,350	4,291	375	143	541	216
Canada	37,921	1,012	26,143	725	307	45	264	72
Canary Islands	6,500	135	--	--	--	--	--	--
Chile	8,100	151	16,667	294	--	--	651	39
France	15,402	254	8,224	154	53	15	--	--
Germany, West	2,349	59	199	3	523	161	55	14
Hong Kong	--	--	--	--	70	16	106	41
India	131	5	--	--	170	74	223	99
Ireland	79,500	1,385	25,889	474	--	--	--	--
Israel	11,925	228	32,996	586	72	21	5	1
Italy	28,735	586	31,421	640	98	16	--	--
Japan	401	14	--	--	411	119	464	145
Korea, Republic of	--	--	16,030	307	21	9	14	5
Mexico	894	40	1,700	60	340	103	227	85
Netherlands	566,191	10,195	574,408	10,522	--	--	21	2
New Guinea	--	--	215	12	--	--	176	20
New Zealand	17,585	423	69,742	1,543	31	5	64	31
Philippines	--	--	--	--	97	49	118	38
South Africa, Republic of	27,810	521	12,117	268	107	11	75	9
Spain	4,000	83	5,000	108	15	2	13	1
Switzerland	16,500	313	5,128	102	--	--	11	1
Tanzania	136	5	387	14	--	--	--	--
Tunisia	48,235	908	27,925	576	--	--	--	--
United Kingdom	15,621	297	19,705	347	--	--	115	12
Uruguay	4,574	101	16,565	332	--	--	5	3
Venezuela	1,045	37	387	19	159	35	257	65
Other	1,862	68	4,114	112	434	116	671	143
Total	1,531,826	27,844	1,846,947	32,409	3,746	1,019	4,654	1,278

Table 15.—U.S. imports for consumption of sulfur, by country

Country	1971: Long tons	1971: Value (thousands)	1972: Long tons	1972: Value (thousands)
Canada	849,700	$10,320	868,374	$8,216
Germany, West	147	31	257	17
Japan	3	1	--	--
Mexico	r 448,766	15,065	268,809	8,052
U.S.S.R.	(1)	2	--	--
United Kingdom	(1)	(1)	11	1
Zambia	--	--	261	2
Total	r 1,298,616	25,419	1,137,712	16,288

r Revised.

1 Less than ½ unit.

WORLD REVIEW

For the world as a whole, production of sulfur in all forms increased substantially over that of 1971. Similarly, there was an increase in sulfur demand, primarily because of an upsurge in the demand for use in the manufacture of fertilizers. However, continuing the pattern prevalent during the past several years, production exceeded demand. As a result, there was an increase in producers' stocks, particularly in the case of Canadian recovered sulfur. Prices remained relatively stable compared with those of 1971, but at levels that were so low as to create serious problems for sulfur producers. The low-price situation was of particular concern to the producers of Frasch sulfur because, as compared with secondary producers, they had no coproduct income available to meet rising production costs. The worldwide oversupply situation was tempered by logistic problems that restricted the movement of sulfur from certain major producing areas, such as Canada, to world markets. As a result, there was more of an effective equilibrium between consumption and available supply than the overall statistics would suggest.

There was a continuation in the trend toward basic restructuring of world sulfur supply sources with increasingly larger supplies being obtained from secondary sources such as sour natural gas and environmental-related sulfur recovery processes. Production of primary elemental sulfur from Frasch and sulfur ore mines remained relatively steady. The pyrites sector of the industry continued to face serious problems as this commodity was becoming increasingly noncompetitive with sulfur from secondary sources.

Canada.—The Province of Alberta's production of recovered elemental sulfur increased from 4.5 million long tons in 1971 to 6.5 million tons in 1972 as a result of the completion of several new plants and the expansion of production at other plants. The production was nondiscretionary, being produced at sour natural gas treatment plants, and was spurred on by an increasingly heavy demand for natural gas in U.S. markets. Shipments of sulfur increased only slightly, from 2.7 million tons in 1971 to 3.1 million tons in 1972. As a result, producers' yearend stocks increased from 5.3 million tons in 1971 to 8.7 million tons in 1972. The value of the marketed sulfur, f.o.b. plant, decreased from approximately $7.22 per ton in 1971 to $5.71 per ton in 1972.[9]

With no new major sulfur recovery plant construction currently underway, it was estimated that Alberta's recovered sulfur production in 1973 would level off at approximately 7 million tons per year. Canada's National Resource Council estimated that unless substantial new markets were developed, producers' stocks of sulfur in Alberta might reach 40 million tons by 1980.[10] In addition to the problem of oversupply, Alberta's producers were faced with the problem of meeting sulfur emission standards at their plants. It was estimated that the cost of complying with environmental standards would be approximately $34 million.[11]

Cyprus.—The mining industry of Cyprus was severely affected by the weakness in international pyrites trade and strong competition from other countries in the European market. Both production and exports have been dropping steadily during the last few years, and producers' stocks have increased. It appeared that the only solution to the problem would be the establishment of a domestic fertilizer industry.[12]

France.—Société Nationale des Pètroles d'Aquitaine (SNPA) strengthened its position in the international sulfur trade when it commissioned a second liquid sulfur tanker. SNPA, owned jointly by the government and private interests, has long been the Nation's leading recovered sulfur producer and a major supplier of sulfur in the European markets.[13]

India.—As a major sulfur importing country with limited domestic sources and a rapidly growing demand, India has been making strenuous efforts to increase its production of this commodity. These efforts have been along the lines of increas-

---

[9] Energy Resources Conservation Board, Province of Alberta, Canada. Cumulative and Annual Statistics, Alberta Oil and Gas Industry, 1972, pp. 14, 31.

[10] U.S. Embassy, Ottawa, Canada. State Department Airgram A-13, Jan. 26, 1973, 2 pp.

[11] U.S. Embassy, Ottawa, Canada. State Department Airgram A-98, Sept. 20, 1972, 3 pp.

[12] Sulphur (London). Cyprus Pyrite Industry in Recession. No. 103, November–December 1972, pp. 35–38.

[13] Sulphur (London). Aquitaine's New Liquid Sulphur Tanker. No. 101, July–August 1972, pp. 20–22.

ing pyrites production, the recovery of sulfur from petroleum refining operations, and the production of byproduct sulfuric acid from metallurgical operations. However, there have been continuing delays in the implementation of these programs. Given further delays, significant increases in sulfur imports were forecast to 1980.[14]

Iraq.—Production of Frasch sulfur at the Mishraq mine of the Iraq National Minerals Co. was officially inaugurated in January 1972. The planned initial operating rate was 250,000 tons per year with the intention of increasing the output to 1 million tons per year by the end of 1972.[15]

Italy.—Typical of the problems facing nations with high-cost sulfur mines is the situation that Sicily's Regional Minerals Agency, Ente Minerario Siciliano (EMS), has encountered in its efforts to phase out Sicily's sulfur mines. These mines were major world sources of sulfur at one time but are no longer economical. Proposals to close the remaining mines have been strongly opposed by political and labor organizations. Despite these repeated efforts, EMS was still operating seven mines employing 3,569 workers. Deficits at these operations have been running between $4 and $5 million per year and now total slightly over $30 million.[16]

Japan.—The Japanese Ministry of International Trade and Industry (MITI) published its estimates of Japanese elemental sulfur supply and demand through 1976. In the past, Japanese supply and demand for sulfur in all forms have been very nearly equal. However, the analysis indicated a very rapid growth in recovered sulfur output, primarily from petroleum desulfurization plants to meet antipollution requirements. It was predicted that by 1976 production of recovered elemental sulfur from these sources would exceed domestic demand by approximately 525,000 tons and would place Japan in the position of becoming a major exporter of sulfur.[17] Another independent analysis of Japanese sulfur supply and demand was in general agreement with the predictions of MITI. This study suggested that in 1980 the production of elemental sulfur at refineries would exceed domestic demand by 1.2 million tons per year.[18]

Mexico.—The export-oriented Frasch sulfur industry was adversely affected by the imposition of antidumping duties on the importation of Mexican sulfur into the United States as, historically, the U.S. market had been Mexico's major customer. As a result of this action, reported imports of Mexican Frasch sulfur into the United States during 1972 were only 60% of those in 1971. Strong efforts were made to develop new markets, with arrangements being made for initial shipments to the People's Republic of China and Chile.[19]

Netherlands Antilles.—The Lago Oil and Transport Co. placed a residual oil desulfurization unit onstream in late 1971. The plant, built at a cost of approximately $35 million, had a rated capacity of 100,000 tons of recovered elemental sulfur per year. Plans were announced for the construction of a second desulfurization plant at a cost of approximately $110 million, with completion scheduled in 1974.[20] These actions were indicative of the projected future expansion of recovered sulfur production from sour crudes in the Caribbean area.

Spain.—Plans were announced for a new oil refinery complex at Tarragona. Feedstocks of the refinery would be low-gravity, high-sulfur crude oil from an offshore field in an area belonging to Spain. Plans for the refinery included a desulfurization unit that would produce 44,000 tons of sulfur per year.[21] The pyrites mining industry, the mainstay of Spain's sulfur industry, was confronted with a decrease in demand for this product in its established foreign markets. Plans were made to improve this situation by the establishment of fertilizer manufacturing industries in Spain utilizing pyrites as a source of sulfuric acid.

U.S.S.R.—Although there was still heavy dependence on pyrites as a source of sulfur, the U.S.S.R. began to emphasize the production of native sulfur ores, Frasch sulfur, recovered sulfur from sour natural gases, and byproduct sulfuric acid from

[14] U.S. Embassy, New Delhi, India. State Department Airgram A-191, May 31, 1973, pp. 95–97.
[15] Sulphur (London). World Markets. Iraq. No. 99, March–April 1972, p. 11.
[16] U.S. Consulate, Palermo, Italy. State Department Airgram A-8, Aug. 25, 1972, pp. 1–2.
[17] Sulphur (London). World Markets. Japan. No. 102, September–October 1972, p. 10.
[18] Japan Petroleum Weekly. Japan's Oil Industry Plagued by Oversupply of Elementary Sulfur. Aug. 28, 1972, pp. 1–2.
[19] U.S. Bureau of Mines. Sulfur: Mexico. Mineral Trade Notes, v. 70, No. 5, May 1973, p. 8.
[20] Sulphur (London). New Plants and Projects. Netherlands Antilles. No. 99, March–April 1972, p. 14.
[21] Sulphur (London). New Plants and Projects. Spain. No. 100, May–June 1972, p. 11.

metallurgical operations. In 1972 the principal producing centers of native sulfur continued to be Rozdol and Yavorov (West Ukraine); Gaurdak, Shorsu, and Changyrtash (central Asia); and Alekseyev and Vodninsk in the Kuybyshev sulfur complex (Volga group). The Rozdol complex is the major producer of native sulfur and, with the Gaurdak combine, provided the bulk of the country's sulfur requirements. A Frasch mine was placed in operation at the Gaurdak combine in 1972. A contract was awarded for the construction of a major recovered sulfur plant at Orenburg. J. F. Pritchard & Co. and a French affiliate, Cie. Centrale d'Etudes Industrielles, will provide equipment and management services for the $76 million plant, which will handle 1,600 million cubic feet of sour natural gas per day and produce over 2,000 tons of sulfur per day.

Table 16.—Elemental sulfur: World production, by country

(Thousand long tons)

Country [1]	1970	1971	1972 [p]
Native sulfur:			
Frasch:			
Iraq	--	--	[e] 200
Mexico	1,276	1,074	847
Poland [e]	[r] 1,772	2,165	2,559
United States	7,082	7,025	7,290
Total	[r] 10,130	10,264	10,896
From sulfur ores:			
Argentina	[r] 39	38	42
Bolivia (exports)	16	10	18
Chile	[r] 107	105	76
China, People's Republic of [e]	128	128	128
Colombia [e]	29	30	32
Ecuador	6	[e] 6	[e] 6
Indonesia	[e] 1	[e] 1	2
Iran [2]	2	2	[e] 2
Italy	[r] 62	71	90
Japan [3]	101	64	17
Mexico	24	23	21
Poland [e]	[r] 869	505	330
Taiwan	6	5	4
Turkey	26	23	21
U.S.S.R.[e]	1,102	1,171	1,180
Total	[r] 2,518	2,182	1,969
Total native sulfur	[r] 12,648	12,446	12,865
Other elemental sulfur: Recovered:			
Algeria [4]	16	[e] [r] 20	[e] 20
Austria [5]	3	3	[e] 3
Belgium [5]	10	23	25
Brazil [4]	9	9	9
Bulgaria [4]	5	6	[e] 6
Canada [6]	[r] 4,369	4,720	6,839
China, People's Republic of [e] [7]	118	118	118
Colombia [e] [4]	4	3	3
Egypt, Arab Republic of [e] [4]	1	1	1
Finland	113	100	117
France [8]	[r] 1,708	1,777	1,703
Germany, East	[r] 107	98	103
Germany, West [5]	173	181	216
Hungary	3	3	[e] 3
Iran [8]	[r] 405	487	555
Israel [e] [4]	8	10	10
Italy [5]	79	73	[e] 74
Japan [9]	[r] 236	339	474
Kuwait [4]	47	36	38
Mexico	59	64	61
Netherlands [5]	32	32	[e] 32
Portugal [4]	3	3	[e] 3
Saudi Arabia [e] [4]	5	5	5
Singapore [4]	1	1	6
South Africa, Republic of [4]	[r] 16	25	30
Spain [10]	6	3	5
Sweden	5	5	5
Taiwan [4]	4	[e] 4	[e] 4
Trinidad [4]	4	[e] 4	[e] 4
U.S.S.R.[e]	472	502	500

See footnotes at end of table.

Table 16.—Elemental sulfur: World production, by country—Continued

(Thousand long tons)

Country [1]	1970	1971	1972 p
Other elemental sulfur: Recovered—Continued			
United Kingdom [11]	36	26	e 30
United States	r 1,457	1,595	1,928
Total other elemental sulfur	r 9,514	10,276	12,930
Grand total	r 22,162	22,722	25,795

e Estimate. p Preliminary. r Revised.
[1] In addition to countries listed, Uruguay produces less than 500 tons of sulfur annually as a byproduct of petroleum refining.
[2] Year beginning March 21 of year stated.
[3] Includes small quantity of byproduct sulfur recovered from sulfide ores as well as sulfur content of sulfur ores.
[4] From petroleum refining.
[5] Includes in part sulfur content of H_2S converted directly into sulfuric acid.
[6] From processing of natural gas, petroleum, tar sands, and sulfide ores.
[7] From petroleum refining and smelting of sulfide ores.
[8] From petroleum refining and natural gas processing.
[9] From petroleum refineries only. Excludes an unreported quantity recovered from sulfide ores, which is included above (see footnote 3).
[10] From distillation of petroleum and lignite and from reduction of SO_2 gas.
[11] Includes sulfur recovered from petroleum refineries and from other unspecified sources.

Table 17.—Pyrites (including cupreous pyrites): World production, by country

(Thousand long tons)

Country [1]	1970		1971		1972 p	
	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content
North America:						
Canada (shipments)	324	158	284	138	116	54
United States [2]	845	339	808	316	741	283
Europe:						
Bulgaria	154	65	e 148	e 63	e 148	e 63
Czechoslovakia e	354	148	354	148	354	148
Finland	948	489	852	383	843	e 382
France	84	38	80	35	e 81	e 35
Germany:						
East e	138	57	138	57	138	57
West	r 563	r 231	487	216	e 482	e 212
Greece	266	116	204	92	e 206	e 92
Hungary e	6	3	7	3	7	3
Italy	r 1,494	r 673	1,480	666	1,360	612
Norway	r 728	r 334	769	353	782	359
Portugal	468	206	552	248	544	239
Romania	794	e 341	e 827	e 354	e 827	e 350
Spain	r 2,070	r 965	1,989	929	1,895	896
Sweden	566	r 284	582	e 280	e 591	e 283
U.S.S.R. e	3,937	2,067	4,183	2,165	4,429	2,264
Yugoslavia	r 284	r e 119	266	r e 112	227	95
Africa:						
Algeria	32	15	27	12	57	26
Morocco (pyrrhotite)	286	86	434	130	414	124
Rhodesia, Southern e	72	30	72	30	72	30
South Africa, Republic of	854	342	738	295	432	173
Asia:						
China, People's Republic of e	1,968	886	1,968	886	1,986	886
Cyprus	r 925	r 448	817	396	628	304
Japan	r 2,720	r 1,269	2,306	1,092	1,555	755
Korea, North e	492	197	492	197	492	197
Korea, Republic of	NA	NA	NA	NA	1	(3)
Philippines	270	125	235	109	252	117
Taiwan	39	15	45	17	30	11
Turkey	90	43	58	26	76	35
Oceania:						
Australia	210	101	255	122	e 256	e 123
Total	r 21,981	r 10,190	21,457	9,870	20,022	9,208

e Estimate. p Preliminary. r Revised. NA Not available.
[1] Pyrites is produced in Cuba, but there is too little information to estimate production.
[2] Sold and used.
[3] Less than one-half unit.

TECHNOLOGY

Technological developments during 1972 were largely related to the recovery or abatement of environmental-related sulfur. Fundamentally, this was brought about by the necessity for the removal of sulfur from solid, liquid, and gaseous effluents, or wastes for the protection of the environment. Additionally, research efforts were devoted to the development of new uses for sulfur because the present and projected supplies of sulfur from secondary sources promised an overwhelming oversupply.

The Bureau of Mines reported on the chemistry of sulfur dioxide as related to methods for removing it from waste gases. The chemistry of current or potential sulfur dioxide (SO_2) removal processes was classified into four groups: (1) Reduction, (2) liquefaction, (3) direct dissolution, and (4) oxidation. Methods that involved reducing SO_2 to elemental sulfur appeared promising. Thermodynamic data were presented as guidelines to postulate which reactions were most likely to occur.[22]

The Bureau of Mines reported that prolonged laboratory and limited pilot plant tests have shown that the Bureau's citrate process is capable of removing 95% to 99% of the SO_2 from industrial waste gases with essentially all of the SO_2 being converted to elemental sulfur. The chemistry and mechanism of the process were described, initial laboratory and pilot plant data were summarized, and second-generation laboratory operation and pilot plant design were reviewed. Preliminary cost estimates were presented for recovering sulfur from copper smelter gas, powerplant flue gas, and Claus plant tail gas.[23]

Ammonia injection followed by gas cooling was demonstrated as an effective means for removing SO_2 from the gas phase in combustion gas mixtures. Product sulfur-bearing salts, which are entrained in the gas, could be removed in a single-stage water scrubber, and ammonia could be effectively regenerated from the scrubber liquid through reaction with sodium hydroxide solutions.[24]

The Bureau of Mines reported that several advancements had been made in a novel process being developed for converting coal into clean fuel oil that has very low sulfur and ash contents. Coal conveyed in recycle oil was propelled by rapid turbulent flow of hydrogen through a reactor packed with immobilized (fixed-bed) catalyst pellets. A relatively low-value, high-sulfur coal having 4.6% sulfur and 17% ash was continuously converted in a small pilot plant into high-value fuel oil having only 0.19% sulfur and 1% ash.[25]

The Office of Coal Research, U.S. Department of the Interior, conducted research programs on methods of converting the Nation's massive coal reserves into required clean fuel forms, and developing more efficient, clean ways of producing electric power from high-sulfur coal. Most of the proposed processes would produce elemental sulfur as a byproduct.[26]

The Bureau of Mines reported on the status of the Synthane process for converting coal to a gas having the essential characteristics of natural gas, with the recovery of sulfur as a byproduct. The report described some of the early experimental work on coal pretreatment and gasification, gas purification, and methanation from which the Synthane process evolved. Also discussed were current plans for pilot plant scale-up of the process.[27]

A review was made of 30 processes for the recovery of sulfur from metallurgical flue gases. The processes were listed and analyzed by process name, sponsor, reducing or absorbing agent, end product, process description, analysis of the process, and stage of development.[28]

The design and operation of a pilot plant for the production of elemental sulfur from smelter stack gases was described.

[22] Haas, L. A. Sulfur Dioxide: Its Chemistry as Related to Methods for Removing It From Waste Gases. BuMines IC 8608, 1973, 19 pp.
[23] Rosenbaum, J. B., W. A. McKinney, H. R. Beard, L. Crocker, and W. I. Nissen. Sulfur Dioxide Emission Control by Hydrogen Sulfide Reaction in Aqueous Solution. The Citrate System. BuMines RI 7774, 1973, 31 pp.
[24] Shale, C. C. Ammonia Injection: A Route to Clean Stacks. Trans. 164th Nat. Meeting, ACS, v. 17, No. 2, pp. 106–113.
[25] Yavorsky, P. M., S. Akhtar, and S. Friedman. Process Developments: Fixed-Bed Catalysis of Coal to Fuel Oil. Preprint of paper presented at 65th Ann. AIChE Meeting Nov. 26–30, 1972, New York. (Available from P. M. Yavorsky, Bureau of Mines, Pittsburgh, Pa.).
[26] Office of Coal Research Annual Report, 1972. Clean Energy From Coal—A National Priority. 1973, 124 pp.
[27] Corey, R. C. Bureau of Mines Synthane Process: Research and Development on Converting Coal to Substitute Natural Gas. Proc. Conf. Synthetic Fuels From Coal, Oklahoma State University, Stillwater, Okla., May 1–2, 1972, 35 pp.
[28] Meisel, G. M. Sulfur Recovery. J. of Metals, v. 24, No. 5, May 1972, pp. 31–39.

The process uses reformed natural gas to reduce sulfur dioxide to elemental sulfur. The capital and operating costs of a commercial installation were estimated.[29]

The status of several new processes for the desulfurizing of residuum fuel oils was reviewed. Residuum desulfurization was experiencing rapid technological progress, chiefly in the area of catalyst improvement. However, commercial development has been limited to a small number of full-scale plants mainly because of economic considerations. Still unanswered was the relative economics of residuum desulfurization compared with the cost of powerplant stack cleanups.[30]

A new refinery tail gas desulfurization process was described that utilized a dry, regenerable absorbent based on copper oxide. It was stated that the advantages of such a dry acceptor material were (1) no loss of thermal buoyancy in the gas and (2) no waste-disposal problem. There were plans to install a commercial unit in a refinery in Japan.[31]

Past, present, and future sulfur sources and uses were reviewed. It was concluded that a rapid increase in sulfur production in the next few years seems inevitable, and that large-scale new uses would be required to avert a depressing surplus situation. Although it appeared that many potential new uses for sulfur existed, it would be necessary to engage in serious research development work to bring such applications to fruition.[32]

The necessity of developing new uses for sulfur was analyzed. The preliminary efforts being made in the United States and Canada to develop new sulfur uses were reviewed, as were several prospective new uses toward which research could be devoted.[33]

The Canadian program for the development of new uses for sulfur was reviewed. The program would be conducted under the auspices of the Sulphur Development Institute of Canada (SUDIC). Financing in the amount of $1 million per year for 3 years would be provided by the Federal Government of Canada, the Provincial Government of Alberta, and industry organizations.[34]

The Bureau of Mines initiated a research program with the objective of developing new high-tonnage uses for sulfur and sulfur compounds. The initial phases of the program consisted of elements pertaining to development of new major uses, testing to establish physical chemical properties of materials made from sulfur, and the systematic collection of basic knowledge that would contribute to identifying new novel consumption potentials. Potential applications that were being investigated included sulfur-asphalt paving materials, sulfur applications for land pollution abatement, characterization of construction materials containing sulfur, and new metallurgical applications for sulfuric acid.[35]

---

[29] Henderson, J. M. Reduction of SO_2 to Sulfur. Min. Cong. J., v. 59, No. 3, March 1973, pp. 59–62.

[30] Davis, J. C. More SO_2-from-Resid Options. Chem. Eng., v. 79, No. 15, July 10, 1972, pp. 36 and 38.

[31] Morrison, J. High SO_2 Removal Claimed for New Desulfurization Process. Petrol. & Petrochem. Internat., v. 12, No. 7, July 1972, pp. 44–48.

[32] Raymont, M. E. D. Sulphur Sources and Uses—Past, Present, and Future. Can. Min. and Met. Bull., v. 65, No. 727, November 1972, pp. 49–54.

[33] Davis, J. C. Sulfur: New Uses Needed. Chem. Eng., v. 79, No. 17, Aug. 7, 1972, pp. 30 and 32.

[34] Gas Processing (Canada). Large Commercialization Program. September–October 1972, pp. 24–25.

[35] Kenahan, C. B., R. S. Kaplan, J. T. Dunham, and D. G. Linnehan. Bureau of Mines Research Programs on Recycling and Disposal of Mineral-, Metal-, and Energy-Based Wastes. BuMines IC 8595, 1973, p. 31.

Talc, Soapstone, and Pyrophyllite

By J. Robert Wells [1]

Total U.S. production of talc, soapstone, and pyrophyllite (known collectively as the talc-group minerals) was greater in 1972 than in any previous year, almost half again as much as a decade ago in regard to both tonnage and total value.

American Talc Co., Inc., previously operating only in Alabama, extended its talc mining to Montana with the acquisition in 1972 of the Willow Creek mine in Madison County. Johns-Manville Corp. (headquarters now in Denver, Colo.) acquired the California properties of L. Grantham Corp. at midyear. Grantham, operating the Warm Springs mine and grinding facilities in the southwestern part of Death Valley, Inyo County, was for many years one of the largest producers of high-quality talc in the United States.

Talcum powder, the familiar and best known form in which talc is used, was unjustly stigmatized in the August 1972 deaths of a number of infants in France. After investigation, it was determined that the tragedy was the result of an excessive quantity of a bactericide that had been added to the powder.

Some industrial talc producers and users were experiencing an increasingly difficult situation in 1972 because of the close mineralogical relationship between talc and a group of other minerals, some of which may become carcinogenic under conditions involving long-continued inhalation. No authoritative distinction has ever been drawn between talc and tremolite, a substantial proportion of which is known to be present in some grades of fibrous talc. That ambiguity and a tendency to regard tremolite as a form of asbestos, in combination with growing emphasis on environmental and health considerations, began to plant doubts concerning industrial talc's hitherto unquestioned classification as an essentially harmless and unrestrictedly usable raw material.

Legislation and Government Programs.—The Defense Materials Inventories prepared by General Services Administration (GSA) showed that Government holdings as of December 31, 1972, included 1,180 short tons of talc (steatite, block or lump), with a market value of $383,500, and 3,900 short tons of talc (steatite, ground) valued at $21,400. Of the block or lump steatite, 980 short tons was listed as excess inventory, as was also the entire quantity of ground material. During calendar 1972, 24 tons of block material, valued at $7,800, was sold from stockpile inventory, but none of the ground talc was disposed of.

[1] Physical scientist, Division of Nonmetallic Minerals.

Table 1.—Salient talc, soapstone, and pyrophyllite statistics

(Thousand short tons and thousand dollars)

	1968	1969	1970	1971	1972
United States:					
Mine production	958	1,029	1,028	1,037	1,107
Value	6,656	7,508	7,773	7,634	7,835
Sold by producers	886	985	948	979	1,084
Value	22,968	26,294	25,980	26,936	33,709
Exports [1]	66	69	105	136	171
Value	3,521	3,713	5,739	4,844	5,791
Imports for consumption	24	20	30	17	29
Value	973	749	1,294	745	1,669
Apparent consumption	844	936	873	860	942
World: Production	4,796	5,162	5,316	5,207	5,252

[1] Excludes powders—talcum (in package), face, and compact.

In June 1972 the Occupational Safety and Health Administration (OSHA) published regulations governing the size and number of fibers of asbestiform minerals (genetically related to talc and often accompanying it in its ores) that may enter the atmosphere at mineral processing plants. Some restraint on industrial utilization of talc, especially of the tremolitic type, was foreseen as a consequence of these controls. The Food and Drug Administration (FDA) set forth a proposal calling for complete elimination of asbestos particles from talc used in the preparation or packaging of all foods and/or cosmetic and drug products. No suggestion was offered concerning sampling and analytical procedures capable of establishing the complete absence of such particles.

DOMESTIC PRODUCTION

The total tonnage of U.S. mine production of talc-group minerals in 1972 was 7% greater than the previous high mark set in 1971, and the corresponding total value was nearly 1% above the then alltime high reached in 1970.

Talc-group minerals were produced in the United States from a total of 54 mines distributed throughout Alabama, Arkansas, California, Georgia, Maryland, Montana, Nevada, New York, North Carolina, Oregon, Texas, Vermont, Virginia, and Washington. Talc or soapstone was mined at one or more locations (48 in all) in each of those 14 States. Domestic production of pyrophyllite consisted, for the first time in more than 20 years, of the output of just one State, North Carolina, where six mines supplied that mineral.

Five States, led by New York and with Texas, Vermont, California, and Montana following in descending order, provided 86% of the total 1972 talc-group tonnage; the same States, in nearly the same order except with Vermont nosing out Texas for second place, also made up 86% of the corresponding total value. The largest domestic producers of talc-group minerals in 1972, accounting jointly for three-quarters of the total tonnage and two-thirds of the total value, were (in alphabetical order) Cyprus Mines Corp., United Sierra Division, with operations in California, Montana, and Texas; Eastern Magnesia Talc Co. in Vermont; L. Grantham Corp. in California; International Talc Co., Inc., in New York; Pfizer Inc., Minerals, Pigments & Metals Division, in California and Montana; Southern Clay Products, Inc., in Texas; R. T. Vanderbilt Co., Inc., with subsidiaries Gouverneur Talc Co., Inc., in New York and Western Talc Co., Inc., in California; and Windsor Minerals, Inc., in Vermont.

Talc minerals were ground for sale or industrial use in 1972 at approximately 40 mills operated by 30 companies in 12 States. Talc or soapstone mined in Arkansas, Nevada and Washington was ground elsewhere, while talc that originated in another State was ground in Nebraska, where there was no mine production.

Table 2.—Talc, soapstone, and pyrophyllite produced in the United States, by State

(Short tons and thousand dollars)

State	1971 Quantity	1971 Value	1972 Quantity	1972 Value
California	153,227	2,084	155,155	1,186
Georgia	53,000	334	45,842	338
North Carolina	85,289	522	89,384	594
Texas	193,830	1,024	221,022	1,262
Vermont	176,104	925	180,239	1,326
Other States [1]	375,847	2,745	415,812	3,129
Total	1,037,297	7,634	1,107,404	7,835

[1] Includes Alabama, Arkansas, Maryland, Montana, Nevada (1972), New York, Oregon, Virginia, and Washington.

Table 3.—Talc, soapstone, and pyrophyllite sold or used by producers in the United States, by class

(Short tons and thousand dollars)

Year	Crude		Ground		Total [1]	
	Quantity	Value	Quantity	Value	Quantity	Value
1968	64,877	331	821,601	22,637	886,478	22,968
1969	81,015	362	904,318	25,931	985,333	26,294
1970	95,561	572	851,956	25,407	947,517	25,980
1971	131,961	789	847,309	26,147	979,270	26,936
1972	89,949	521	994,263	33,188	1,084,212	33,709

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

CONSUMPTION AND USES

Apparent consumption of talc-group minerals in the United States in 1972 (total sales plus imports minus exports) amounted to 942,000 short tons (compared with 860,000 tons in 1971 and 873,000 tons in 1970), setting a new high mark for this figure, almost 1% above the previous record established in 1969.

Reported sales of ground material totaled 17% more in tonnage than in 1971, and the total value was 27% higher, with especially large gains in tonnage being scored by California, New York, and Texas and in value by California, Georgia, New York, North Carolina, and Texas.

Thirty percent of the total quantity of talc, soapstone, and pyrophyllite sold or used by domestic producers in 1972 was consumed in the manufacture of ceramics and 16% in paints. A salient feature of the 1972 end-use distribution of these materials was the marked difference in the proportion allocated to toilet preparations (12%, compared with 3% in 1971 and 2% in 1970), a divergence that is thought to be more a reflection of anomolous reporting in previous years than an indication of an abrupt upsurge in this utilization. The shares of the 1972 total that were taken by the other major consumption categories (insecticides, paper, roofing, and rubber products) were no more than fractionally different from the respective 1971 figures.

Table 4.—Pyrophyllite [1] produced and sold by producers in the United States

Year	Production	Total sales	
	Short tons	Short tons	Value (thousands)
1968	130,624	120,319	$1,748
1969	104,347	110,816	1,632
1970	120,077	95,735	1,317
1971	101,030	90,477	1,155
1972	W	90,482	1,236

W Withheld to avoid disclosing individual company confidential data.
[1] Includes sericite schist (1968–70).

Table 5.—Talc, soapstone, and pyrophyllite sold or used by producers in the United States, by use

(Short tons)

Use	1971	1972
Ceramics	270,358	329,406
Paint	155,140	173,663
Toilet preparations	31,249	132,000
Exports	101,797	100,746
Insecticides	63,381	65,465
Paper	52,886	58,505
Refractories	27,795	40,119
Rubber	27,098	36,215
Roofing	35,189	32,913
Textiles	4,985	12,010
Asphalt filler	35,259	11,769
Other uses [1]	174,133	91,401
Total	979,270	1,084,212

[1] Includes plastics, stucco, floor tile, foundry facings, rice polishing, crayons, art sculpture, and other uses.

STOCKS

It was estimated, on the basis of a comparison of the figures reported in 1972 for domestic production of talc-group minerals and for the quantity of those materials sold or used, that U.S. producers may have had 167,000 short tons of mined talc, soapstone, and pyrophyllite on hand (crude, ground, or in process) on December 31, 1972, compared with 144,000 tons on that date in 1971 and 205,000 tons in 1970.

PRICES

The average of unit values reported by domestic producers of crude talc, soapstone, and pyrophyllite in 1972 was $7.08 per short ton, compared with $7.36 in 1971 and $7.56 in 1970. In contrast to that decline, the average unit value reported for all talc-group minerals sold or used by domestic producers (mostly processed material but not including finished cosmetic preparations) increased sharply to $31.09 per ton, compared with $27.51 in 1971 and $27.42 in 1970.

Engineering and Mining Journal, December 1972, quoted prices for domestic ground talc in carload lots, f.o.b. mine or mill, containers included, per short ton, as follows:

Vermont:	
98% through 325 mesh, bulk	$20.00
99.99% through 325 mesh, bags:	
Dry processed	55.00
Water beneficiated	81.00
New York:	
96% through 200 mesh	28.00
99.9% through 325 mesh	44.50
100% through 325 mesh, fluid energy ground	80.00–90.00
California:	
Standard	37.00– 53.00
Fractionated	37.00– 71.00
Micronized	62.00–104.00
Cosmetic/steatite	44.00– 65.00
Georgia:	
98% through 200 mesh	14.00
99% through 325 mesh	25.00
100% through 325 mesh, fluid energy ground	75.00

The price range quoted in Chemical Marketing Reporter, December 25, 1972, for carload lots of imported Canadian talc, ground, in bags, was from $20 to $35 per ton, f.o.b. works.

American Paint Journal, November 27, 1972, 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: Fibrous and semifibrous, bags, mill:	
98% through 325 mesh	31.00
99.4% through 325 mesh	40.00
Trace retained on 325 mesh	80.00
Fine micron talcs (origin not specified)	68.00–111.50

FOREIGN TRADE

Exports.—The United States exported a greater quantity of talc-group materials in 1972 than in any previous year, topping the former record for tonnage (1971) by 26% and for value (1970) by 1%. The exported material went to a total of 57 countries, 18 in the Western Hemisphere, 17 in Asia/Oceania, 16 in Europe, and six in Africa. Sharply increased shipments to two major recipients, Canada and Mexico (up 54% and 25%, respectively, from 1971 figures), were the most notable factors contributing to the new record total.

Imports.—In 1972 the total value of U.S. imports of talc minerals for consumption reached the highest level on record, 29% above the mark set in 1970, and the 1972 tonnage was exceeded only by that of 1970, (3% higher). Outstandingly in first place among 1972 talc imports were receipts from Italy which added up to the largest tonnage from there since 1963 and to the highest total value ever recorded from any one country in any one year.

Tariffs.—Schedules applicable throughout 1972 provided for import duties on the various classifications of talc as follows: Crude and not ground, 0.02 cent per pound; ground, washed, powdered, or pulverized, 6% ad valorem; cut or sawed, or in blanks, crayons, cubes, disks, or other forms, 0.2 cent per pound; and other, not specially provided for, 12% ad valorem.

Table 6.—U.S. exports of talc, soapstone, and pyrophyllite, crude and ground

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1970	105	5,739
1971	136	4,844
1972	171	5,791

Table 7.—U.S. imports for consumption of talc, steatite or soapstone, by class and country

(Short tons and thousand dollars)

Year and country	Crude and unground		Ground, washed, powdered or pulverized		Cut and sawed		Total unmanufactured	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value[1]
1970	18,426	697	11,207	408	355	189	29,988	1,294
1971:								
Canada	4,821	48	3,200	85	4	3	8,025	136
France	--	--	4,225	137	--	--	4,225	137
Germany, West	--	--	2	(2)	--	--	2	(2)
India	--	--	--	--	2	1	2	1
Italy	2,756	142	1,462	123	6	5	4,224	270
Japan	--	--	--	--	282	167	282	167
Korea, Republic of	--	--	622	34	--	--	622	34
Total	7,577	190	9,511	379	294	176	17,382	745
1972:								
Canada	3,639	37	3,027	93	7	4	6,673	134
France	--	--	3,652	135	--	--	3,652	135
Hong Kong	--	--	--	--	171	92	171	92
India	--	--	--	--	3	1	3	1
Italy	15,102	833	748	73	--	--	15,850	906
Japan	--	--	--	--	502	324	502	324
Korea, Republic of	--	--	2,044	48	52	28	2,096	76
Thailand	138	1	--	--	--	--	138	1
Total	18,879	871	9,471	349	735	449	29,085	1,669

[1] Does not include talc, n.s.p.f.: 1970, $5,651; 1971, $17,997; 1972, $128,925.
[2] Less than ½ unit.

WORLD REVIEW

A private firm of marketing consultants, C. H. Kline & Co., of Fairfield, N.J., scheduled for completion in late 1972 two new surveys of the current and projected marketing situation, both domestic and international, of a number of filler and extender pigments, among which talc is a prominent example. The announced objective of the first study was a review of new developments and future trends in the U.S. market for those commodities; that of the second was an analysis of the factors and sometimes complex interrelationships affecting that market in parts of Europe, specifically Spain and the countries of the European Economic Community and the European Free Trade Association.

Australia.—Talc reserves at the Seabrook deposit near Meekatharra, West Australia, property of Westside Minerals, N.L., were estimated at 1 to 2 million tons of 76% ore easily extractable by selective open pit methods. Preparations were made to begin mining at an initial rate of 100,000 tons per year, and plans were revealed to process the output in a milling plant to be constructed especially for that purpose at the Indian Ocean port of Perth. Australia's total annual production of talc has ranged in recent years from less than 20,000 tons to over 140,000 tons.

Brazil.—Although no official quantitative data are published, Brazil has a substantial yearly output of talc and soapstone, mostly from Paraná and Minas Gerais, while lesser quantities are mined in Rio de Janeiro, São Paulo, and Bahia. There is a significant export trade in talc, and a growing cottage industry utilizes important quantities of soapstone in the production of hand-carved art objects.

Canada.—Three companies produce talc in Canada, one in Ontario and two in Quebec. The leader, Baker Talc Ltd., with properties near South Bolton, Quebec, has developed beneficiation procedures for upgrading its talc product to paint and paper grade; that process, involving both froth flotation and high-intensity wet magnetic separation, was placed in limited-scale operation in 1970 and went to full-scale in 1972.

Pyrophyllite was found to make up the bulk of an intrusive body of relatively recent geological age at the west end of the working pit of the newly developed Island

Copper Mine on Vancouver Island, British Columbia. Plans for commercializing the discovery were not mentioned.[2]

China, People's Republic of.—Talc-group minerals are among China's more important export items, and as much as half the yearly output of high-quality material from the Ta–ling deposit at Liaoning, southern Manchuria, may be sold overseas. Japan received about two-thirds of the approximately 80,000 tons exported in 1970, and lesser quantities went to destinations in Poland, the United Kingdom, and the U.S.S.R.

Egypt, Arab Republic of.—The most important sources of talc in Egypt are the Darhib and El Atshan mines in the Eastern Desert, the region bordering on the Gulf of Suez and the Red Sea. Large-scale production of ceramic- and pharmaceutical-grade talc from that area was curtailed in 1968 because of a heavy accumulation of stocks in the preceding years.

France.—An apparent outbreak of encephalitis in northern France that was accompanied by symptoms of acute skin irritation and which affected only small infants, resulted in at least 20 deaths. The illness was traced to the use in each case of one particular brand of baby powder, and statements were made that the fatalities had been caused by talcum powder. The French government's investigation showed that the tragic episode was attributable, rather, to an error in the formulation of the product. The preparation had been allowed to go on sale containing a lethal concentration (as high as 6%) of an effective but dangerous antibacterial agent, hexachlorophene.

Germany, West.—Talc imports in 1971 amounted to 10,300 short tons, 4% less than in the previous year. Austria was the principal source of the 1971 imports with 39% of the total (up from 36% in 1970). Other major suppliers in 1971 were Italy with 17%, France with 13% and Norway with 11%. The United States furnished 3% of West Germany's imported talc in 1970 but only a fraction over 1% in 1971.

India.—Recent mineral discoveries in northwest and north-central Kashmir State included talc deposits in the districts of Gilgit and Baltistan. Prospecting licenses were being granted seekers of talc and other specified minerals in that region with the understanding that such licenses will be convertible to 20- or 30-year mining leases in the event of successful exploration.

Italy.—Italian exports of talc-group minerals in 1971 amounted to nearly one-third of the total quantity produced, only fractionally different from the previous year's proportion. Among the principal recipients of the material exported in 1971 were West Germany, the United Kingdom, and the United States.

Korea, Republic of.—The government-controlled Korea Mining Promotion Corporation announced that a $4.8 million loan from the Asian Development Bank was being negotiated for the procurement of new mining equipment. The stated objective of this procurement and related modernization activities was the establishment of a situation to encourage production and use of an extensive list of domestic mineral raw materials. Among the products mentioned, talc and pyrophyllite (from the Tongyang and Sungsan mines, respectively) are rapidly attaining major importance as earners of foreign exchange.

South Africa, Republic of.—Figures for 1972 mineral production included 9,656 short tons of talc and 2,270 short tons of "wonderstone," the name given to a special variety of pyrophyllite that is mined locally. Exports accounted for only 2% of the tonnage of talc and 12% of the pyrophyllite, but the unit values of the exported materials (equivalent respectively to $51.00 per short ton and $213.00 per short ton) were indicative of the exceptional grades involved.

Swaziland.—A group of Japanese companies, headed by a Mitsubishi subsidiary, held discussions with Swaziland Industries (Pty), Ltd., with a view to initiating exploitation of a newly discovered deposit of pyrophyllite in the southwestern Highveld area, presumably to supply material for shipment to Japan. Swaziland Industries currently mines pyrophyllite from a deposit near Sicunusa in the Manzini district, but the entire output of that operation is exported to the Republic of South Africa.

Sweden.—Production of talc and soapstone in Sweden has averaged about 30,000

[2] Mining Magazine (London). Island Copper Project. V. 127, No. 4, October 1972, pp. 344–345, 347.

short tons annually throughout the last decade, but consumption of those materials has consistently exceeded the domestic output, and imports (chiefly from Austria and Norway) have substantially outweighed exports. In 1972 Sweden's mines yielded 26,450 tons of talc-group minerals, and 24,000 tons was imported at a total cost of $1.5 million. Only 1,800 tons, valued at $38,000, was exported.

Table 8.—Talc, soapstone, and pyrophyllite: World production by country

(Short tons)

Country [1]	1970	1971	1972 p
North America:			
Canada (shipments)	72,055	65,562	80,000
Mexico	2,320	1,889	e 1,870
United States	1,027,929	1,037,297	1,107,404
South America:			
Argentina	34,066	38,705	e 38,600
Brazil (talc) e	143,000	143,000	143,000
Chile	r 2,315	1,938	2,021
Colombia	1,899	2,177	2,477
Paraguay	132	176	243
Peru (pyrophyllite)	702	e 660	e 660
Uruguay (ground talc)	1,801	939	1,458
Europe:			
Austria	110,406	100,995	91,725
Finland	69,140	110,979	99,568
France	r 241,538	279,579	e 280,000
Germany, West (marketable)	37,265	32,692	34,743
Greece	6,614	2,045	e 2,200
Hungary	17,801	e 17,600	e 17,600
Italy (talc and steatite)	170,657	151,973	163,607
Norway (ground talc)	77,771	e r 78,000	e 78,000
Portugal	1,992	1,405	1,327
Romania	62,532	e 65,000	65,000
Spain	43,665	44,911	e 45,200
Sweden	r 35,688	26,505	e 26,450
U.S.S.R. e	r 420,000	r 420,000	e 430,000
United Kingdom	12,074	e 12,000	e 12,000
Africa:			
Botswana	r 40	143	--
Egypt, Arab Republic of	7,151	6,968	e 6,940
Morocco	249	(2)	--
South Africa, Republic of [3]	13,657	12,975	11,926
Swaziland (pyrophyllite)	280	225	e 220
Zambia	(4)	160	4,905
Asia:			
Burma	235	237	e 240
China, People's Republic of e	165,000	165,000	165,000
India	185,641	208,094	209,189
Japan [5]	r 1,847,855	1,731,827	1,661,114
Korea, North e	88,000	99,000	110,000
Korea, Republic of (talc and pyrophyllite)	224,952	234,185	259,867
Pakistan (soapstone)	3,900	e 5,200	4,846
Philippines	1,753	1,452	1,110
Taiwan (soapstone)	42,678	43,036	27,328
Thailand (pyrophyllite)	--	55	1,709
Oceania: Australia (talc)	141,253	62,186	e 62,000
Total	r 5,316,006	5,206,770	5,251,547

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 estimates of output levels.

2 Revised to zero.

3 Includes talc and wonderstone (pyrophyllite).

4 Less than ½ unit.

5 Includes talc and pyrophyllite; in addition, pyrophyllite clay is produced as follows in short tons: 1970—507,112; 1971—354,160; 1972—343,180.

TECHNOLOGY

In an annual review of materials used for ceramic processing, an industrial journal presented informative summaries on the nature, occurrence, and applications of a number of talc-group minerals and related materials.[3] Research was successfully concluded in an effort to develop an advantageous method for beneficiating western talc ores in which the mineral is present in the soft, platy form. The procedure finally selected was characterized as an attrition-scrubbing sedimentation process.[4] The research program of the Bureau of Mines included experiments to evaluate the possible use of talc, glass fiber, and dicyclopentadiene in a sulfur matrix for building purposes. No expedient was discovered for combating destructive changes found to take place in the composites upon aging, and the outlook was considered to be unfavorable.

The raw materials (including talc and pyrophyllite), as well as the technologically advanced methods and equipment recommended for efficiently fabricating them into ceramic tile were discussed in a journal article,[5] and another article reviewed operations of a specific installation where those materials and techniques similar to those advocated are being employed.[6] Some of the technologic considerations involved in the utilization of a particular type of talc in a specified application were the subject of an article.[7] A detailed description of the emission-abatement program at facilities of a major talc producer was presented at a professional society meeting and was made available in booklet form.[8]

Particles of platy talc ore of cosmetic grade are effectually delaminated in a patented procedure by being subjected to a variety of selective forces that achieve maximum reduction in the thickness of the particles while leaving their lengths and widths relatively unchanged. The resulting low-density, high-slip product is described as lustrous and possessing optimum texture and lubricity so as to be exceptionally suitable for use in body powders.[9] Talc and graphite were specified to serve as thickeners for mixing with finely divided polytetrafluoroethylene and colloidal chrysotile asbestos to be combined with a major proportion of a lubricating oil in a patented formulation for a high-pressure lubricating grease.[10] A patent was issued for an improved printing ink, composed of ground talc, a pigment, and polyamide epichlorohydrin dispersed in a solvent.[11]

A process and equipment were patented for accelerating granules of talc, or other mineral substances, through a nozzle to supersonic velocities in order to pulverize the material by the standing shock wave so produced.[12] Finely divided talc, either micaceous or granular and amounting to as much as 50% of the total weight, can be added to a specified organic material to produce a patented substrate that will receive a metal surface suitable for electroplating.[13] A process was patented for reacting talc, lithium carbonate, sodium carbonate, and aqueous sodium silicate to produce a substance that can be dried for use in catalytic applications normally served by certain naturally occurring materials of the montmorillonite clays group.[14]

---

[3] Ceramic Industry Magazine. Steatite. V. 100, No. 1, January 1973, p. 28.
———. Cordierite V. 100, No. 1, January 1973, p. 58.
———. Pyrophyllite. V. 100, No. 1, January 1973, p. 96.
———. Sericite. V. 100, No. 1, January 1973, p. 99.
———. Talc. V. 100, No. 1, January 1973, p. 107.
———. Wonderstone. V. 100, No. 1, January 1973, p. 112.

[4] Roe, Lawrence A. High Purity Talc From Western Ores. Pres. at Fall Meeting, Soc. Min. Eng. AIME, Birmingham, Ala., Oct. 18–20, 1972, Preprint 72–H–312, 16 pp.

[5] Altschuler, Otto. The Ideal Tile Plant. Ceram. Ind. Mag., v. 99, No. 2, July 1972, pp. 36–37.

[6] Jordan, Roy, Jr. Flamingo Tile: Maverick Methods, Rewarding Results. Ceram. Age, v. 88, No. 5, May 1972, pp. 15, 18–19.

[7] O'Shaughnessy, James G. Reformulating Calcium Base Pigments With New York State Talc. Amer. Paint J., v. 56, No. 34, Feb. 7, 1972, pp. 15–17.

[8] Erdman, G. R. Dust Control at Gouverneur Talc Company, Inc. Pres. at Fall Meeting, Soc. Min. Eng., AIME, Birmingham, Ala., Oct. 18–20, 1972, Preprint 72–H–39, 16 pp.

[9] Ashton, W. H., and R. S. Russell. Talc Beneficiation. U.S. Pat. 3,684,197, Aug. 15, 1972.

[10] Curtis, G. C. (assigned to Esso Research and Engineering Co.). Extreme Pressure Grease. U.S. Pat. 3,639,237, Feb. 1, 1972.

[11] Schneider, D. J. (assigned to Howard Paper Co.). Bleed Resistant Ink. U.S. Pat. 3,642,502, Feb. 15, 1972.

[12] Dille, R.M., and W. C. Schlinger (assigned to Texaco, Inc.). Fluid Energy Grinding Method and System. U.S. Pat. 3,643,875, Feb. 22, 1972.

[13] Peppe, W., H. M. Khelghatian, and A. J. Lutz, Jr. (assigned to Standard Oil Co.). Talc Filled Metallizable Polyolefins. U.S. Pat. 3,663,260, May 16, 1972.

[14] Orlemann, J. K. (assigned to Pfizer, Inc.). Process for Producing Synthetic Hectorite-Type Clays. U.S. Pat. 3,666,407, May 30, 1972.

A patent was granted for a process in which talc, clay, feldspar, wollastonite, or other ceramic materials are combined in an aqueous mixture with an approximately equal quantity of exfoliated vermiculite, and that mixture is pressed into shapes that are then dried, fired, and glazed to produce strong and lightweight disposable containers.[15] In a process for which a patent was granted, an aqueous dispersion of pyrophyllite is applied to one surface of a paper form, after which the object is dried, coated with a glazing material, and fired to vitrify the glaze and consume the combustible base, thus producing inexpensive, thin-walled ceramic ware to be discarded after a single use.[16]

---

[15] Hardy, P. W., and O. M. Peterson (assigned to American Can Co.). Method of Making Glazed Ceramic Bonded Expanded Vermiculite Articles. U.S. Pat. 3,689,611, Sept. 5, 1972.

[16] Simmen, F. G. (assigned to Hall China Co.). Manufacture of Disposable Ceramic Dishes From High-Alkali Pyrophyllite. U.S. Pat. 3,655,843, Apr. 11, 1972.

Thorium

By Roman V. Sondermayer [1]

As in the past, there was no direct mine production for thorium as such during 1972, and demand for thorium was not the decisive factor in determining its supply. Production of thorium was essentially a byproduct of the monazite operations for rare earths. Consequently, there was a continuing and excessive stock of thorium-bearing raw materials. The weak market continued, but the long-term potential for use of thorium was considered good. Demand for thorium hardener, used in magnesium alloys for aerospace applications, increased slightly. New orders for thorium-uranium-fueled high-temperature, gas-cooled reactors (HTGR) improved the long-range demand potential for thorium nuclear fuels. Continuing research may introduce new industrial applications for thorium and its compounds in metallurgy and nuclear fuels, thus resulting in larger consumption of thorium.

The most significant events related to thorium during 1972 were the beginning of a new beach-sand (containing monazite) operation in Florida, the preliminary accord for the sale of two HTGR's to Southern California Edison Co., and the participation of Gulf General Atomic Co. (GGA) in construction of a HTGR in West Germany.

Legislation and Government Programs.—The entire inventory of thorium held by the Government was authorized for disposal. However, there was no response to the request for bids during 1972, and thorium and its compounds were not sold from the stockpile. At the end of 1972, 1,789 tons of thorium-oxide (ThO_2) equivalent were held by the Government in stockpile.

Effective January 1, 1972, under the "Kennedy round" schedule of tariff reductions, ad valorem duties were reduced to 17.5% on thorium compounds, 6% on metal, and 7.5% on thorium alloys.

DOMESTIC PRODUCTION

Mine Production.—Production of byproduct monazite from a Pleistocene beach-sand deposit, located 35 miles inland and 10 miles fron Green Cove Springs, Fla., started in October 1972. Titanium Enterprises, jointly owned by American Cyanamid Co. and Union Camp Corp., became the second domestic monazite producer. In addition to monazite, mine products included ilmenite, leucoxene, rutile, and zircon.

Humphreys Mining Co., with its operation near Folkston, Ga., remained the largest producer of monazite in the country. Output was slightly lower in 1972. Estimated ThO_2 content remained at 5%. Heavy-mineral sands were mined by suction dredge for their titanium minerals and zircon content. The byproduct monazite was sold under contract to W. R. Grace & Co., Chattanooga, Tenn. Monazite was processed essentially for its rare earths oxide (REO) content. Thorium-bearing residues were stockpiled for processing as needed.

Humphreys Mining Co. continued land rehabilitation of an area disturbed by mining. Mill waste was used as fill, and, after grading, topsoil was respread, fertilized, and planted with grass. The company was presented with the State of Georgia first honor award for land reclamation achievements.

Refinery Production.—The principal domestic firms processing monazite for

[1] Physical scientist, Division of Nonferrous Metals.

rare-earth elements and thorium were W. R. Grace & Co., at Chattanooga, Tenn., and Lindsay Rare Earths, affiliated with Kerr-McGee Chemical Corp., West Chicago, Ill. A number of thorium-processing companies maintain stocks of various compounds and the metal for nonenergy use and for nuclear fuels.

Table 1.—Companies processing and fabricating thorium, 1972

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, and metal.
General Electric Co	San Jose, Calif	Nuclear fuels.
Do	Wilmington, N.C	Do.
W. R. Grace & Co., Davison Chemical Div.	Chattanooga, Tenn	Processes domestic and imported monazite; produces oxide; stocks of hydroxide and metal powder.
Gulf General Atomic Co	San Diego, Calif	Nuclear fuels.
Gulf United Nuclear Fuels Corp	Hematite, Mo	Do.
Do	New Haven, Conn	Do.
Hitchcock Industries, Inc	South Bloomington, Minn.	Magnesium-thorium alloys.
Kerr-McGee Chemical Corp	Cimarron, Okla	Nuclear fuels.
Lindsay Rare Earths	West Chicago, Ill	Processes imported monazite; stocks of thorite; produces oxide, nitrate, and oxalate.
NL Industries, Inc	Albany, N.Y	Nuclear fuels.
Nuclear Chemicals and Metals Corp	Huntsville, Tenn	Do.
Nuclear Fuel 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.
Wellman Dynamics Corp	Creston, Iowa	Magnesium-thorium alloy.
Westinghouse Electric Corp	Bloomfield, N.J	Processes compounds; produces metallic thorium.
Do	Columbia, S.C	Nuclear fuels.

CONSUMPTION AND USES

Based on monazite production and foreign trade figures, apparent consumption of thorium (in terms of ThO_2 equivalent) was estimated at 300 tons during 1972. However, actual domestic industrial consumption was lower because the monazite supply was processed for its rare earth content, and most of the thorium residue remained in company holding areas.

Nonenergy industrial consumption was estimated at 100 to 150 tons ThO_2 equivalent. The major uses were in incandescent gas lamp mantles; hardener for magnesium-thorium alloys in aerospace applications; dispersion hardening of metals such as nickel, tungsten, and stainless steel; and electronic, refractory and chemical (catalytic) applications.

In the nuclear field, research and development studies continued on thorium-uranium fuels, reactor concepts for these fuels, and thorium fuels reprocessing. Thorium-uranium fuels (Th_{232}-U_{232} fuel cycle) are used in the HTGR, the molten-salt breeder reactor, and seed-blanket loadings for the pressurized water reactor.

During 1972, plans for construction of two HTGR nuclear power plants were announced. The Southern California Edison Co. signed a letter of intent with GGA, of San Diego, Calif., a Division of Gulf Oil Corp., to design and supply two 770,000-kilowatt HTGR's to be located in the eastern California desert. A site for the facility had not been selected at yearend. The first unit was tentatively scheduled for operation in 1981. Southern California Edison has also taken an option for two additional, larger capacity HTGR units that would be located at another site.

A second HTGR plant was planned by Delmarva Power and Light Co., Wilmington, Del. The new nuclear power station will consist of two 700,000-kilowatt HTGR's, and the total costs were reported to be $680 million. The site is located 15 miles south of Wilmington. Reportly, the first unit would be operational in 1979, and the second one 2 years later. GGA will design and supply the HTGR's.

Table 2.—U.S. foreign trade in thorium and thorium-bearing materials

(Quantity in pounds unless otherwise specified)

	1970		1971		1972		Principal sources and destinations, 1972
	Quantity	Value	Quantity	Value	Quantity	Value	
EXPORTS							
Ore and concentrate (ThO_2 content)	81	$1,296	--	--	--	--	
Metals and alloys [1]	5,503	86,021	65,592	$943,930	16,624	$291,048	Italy 14,119; Canada 1,695; Japan 554.
Compounds [1]	4,045,549	24,579,293	6,021,148	38,498,069	6,714,148	46,614,501	Canada 4,170,598; United Kingdom 2,521,235.
IMPORTS							
Ore and concentrate:							
Monazite (short tons)	3,448	427,411	3,373	383,733	894	$88,767	All from Malaysia.
ThO_2 content [e]	413,800	--	404,800	--	107,300	--	
Waste and scrap	--	--	--	--	15	285	All from Canada.
Compounds:							
Nitrate	5	382	1,100	1,891	4,502	15,612	All from France.
Oxide	10	280	2,481	8,692	317	1,833	France 290.
Oxide equivalent, in gas mantles [e 2]	4,100	409,110	5,900	618,616	5,804	539,558	United Kingdom 2,795; Austria 1,000; Malta 692; Italy 600; West Germany 464.
Other	252	23,253	227	28,195	151	22,811	Switzerland 118.

[e] Estimate.
[1] Includes uranium; thorium and uranium are undifferentiated in official statistics.
[2] Based on manufacture of 1,000 gas mantles per pound ThO_2.

FOREIGN TRADE

During 1972, imports of monazite largely for the rare earth content, decreased sharply (83.5%) from 1971 levels. Malaysia was the only supplier of monazite during 1972. Imports from Australia, the largest supplier in 1971, ceased during 1972. Imports of thorium oxides decreased significantly (87%), but imports of thorium nitrate were about four times higher than in 1971. These compounds were imported from France. Imports of gas mantles decreased slightly (1.6%) from 1971 levels. The United Kingdom and Austria were the principal suppliers.

Minor imports of thorium waste and scrap were registered during 1972 for the first time since 1970.

In official statistics, thorium and uranium exports are undifferentiated. Consequently, it is impossible to evaluate thorium exports only. However, the composite figure for thorium and uranium exports indicated a decrease in metal and alloy exports and an increase in exports of compounds.

WORLD REVIEW

Australia, India, Brazil, Malaysia, and the United States were the principal world producers of monazite concentrate, the main source of thorium, during 1972. No raw material was mined for recovery only of ThO_2; output of monazite and ThO_2 resulted from operations of the rare earth industry.

Brazil.—During 1972 no major changes were reported in the beach sand industry. The Commissão Nacional de Energia Nuclear (CNEN) controlled the overall production of monazite in the country. CNEN, through Administração da Produção da Monazita (APM), operated workings at Itabapoana (Rio de Janiero) and Cumuruxatiba (Bahia). Monazita e Ilmenita do Brasil (MIBRA), a privately owned company, operated facilities for the production of monazite at Guarapari.

Law 5740, enacted in December 1971, created a mixed Government-private company, Cia. Brasileira de Tecnologia Nuclear (CBTN), to operate under CNEN in certain commercial aspects of nuclear energy. The stated objectives of CBTN were reported as follows: to prospect for and mine nuclear and associated mineral deposits through the Cia. de Pesquisa de Recursos Minerais (CPRM), and the development of nuclear energy and its uses. CBTN will have headquarters in Brasilia, the company's capital will amount to $18 million. The law stipulates that only Brazilians can be directors and members of the fiscal council of the company.

Canada.—There has been no thorium production since 1968, although large thorium resources exist in Canada. Some

Table 3.—Monazite concentrate: World production by country

(Short tons)

Country [1]	1970	1971	1972 p
Australia	4,891	4,854	5,537
Brazil	2,544	1,502	2,453
India [2]	4,004	4,664	e 4,700
Malaysia [3]	1,827	1,621	1,927
Mauritania e	110	110	110
Mozambique	2	—	—
Nigeria	14	102	11
Sri Lanka (formerly Ceylon)	18	7	e 10
Thailand	119	123	188
United States	W	W	W
Zaire	158	239	e 240
Total	13,687	13,222	15,176

e Estimate. p Preliminary. W Withheld to avoid disclosing individual company confidential data.

1 In addition to the countries listed, Indonesia and North Korea produce monazite, but information is inadequate to make reliable estimates of output levels.

2 Year beginning April 1 of that stated.

3 Exports.

research continued to reduce costs and produce high-purity thorium.

In addition, authorities prepared detailed proposals for legislation regulating ownership in the nuclear industry. At yearend, no information was available on the status of this legislation.

Germany, West.—During 1972, Gulf Energy and Environmental Systems Inc. (GEES) acquired a 45% interest in Hochtemperatur Reaktorbau GmbH (HTR); Brown, Boveri and Co., Mannheim, retained 55% interest in the new company. GEES as part owner will license HTR to use GGA-developed HTGR technology. In return, GEES would gain access to the technology of the thorium high-temperature reactor (THTR) with its "pebble bed" fuel concept that HTR expects to demonstrate in a prototype reactor at Schmehausen, near Dortmund.[2]

India.—According to Indian Rare Earths Ltd. (IRE), monazite production increased nearly 7% during the fiscal year ending March 1972.[3]

Production and sales data for fiscal 1971 and 1972 were as follows, in short tons:

	1971 [1]	1972 [1]
Monazite processed	3,903	4,165
Production of thorium hydroxide	1,378	1,499
Sales of monazite:		
Quantity	3,745	4,677
Value thousands	$147	$181
Sales of thorium hydroxide [2] do	$68	NA

[1] Fiscal year ending March.
[2] To Indian Government.

The IRE will make a feasibility study of the mineral sand deposits along the Orissa coast for assessing the monazite content. Mineral sands are found near Gopalpura, on a 25-mile stretch of the Orissa coast. If results of the study are favorable, IRE plans to build a mineral separation plant in Orissa. IRE also planned to double the capacity of the Chavara mineral sand plant in Kerala State from 110,000 to 220,000 short tons per year and to expand capacity of the Manavalakurichi plant from 55,000 to 88,000 short tons per year. The company continued to operate the thorium plant at Trombay as agent of the Government of India.[4] The company also discussed with the Department of Atomic Energy and Bhabha Atomic Research Center the details of a program of scientific cooperation with the Center for Research and Development at Trombay.

Indonesia.—The State-owned Perussahaan Negara Tambang Timah planned to extract monazite as a byproduct of tin mining. Expansion of facilities to increase tin production and separate marketable monazite concentrates was reported.[5]

Sri Lanka (formerly Ceylon).—The Ceylon Mineral Sands Corp. announced plans to expand its mineral sand facility at Pulmoddai. Equipment from the China Bay plant will be dismantled and used for the expansion. Upon completion, the new integrated sand complex at Pulmoddai will have an annual capacity of 200,000 tons of raw sand yielding 500 tons of monazite and other products. During 1972, a special committee representing the Ministry of Industries, Ministry of Irrigation, and others was formed to ensure timely construction of ancillary facilities for the project.[6]

South Africa, Republic of.—During 1972, two discoveries of monazite were reported The first indicated monazite reserves in sand dunes near Garies, Namaqualand. A concentration of heavy minerals was first noticed by airborn radiometric survey. Reserves were reported at 95 million tons of sand with a 10% content of heavy minerals. The second discovery was in the northeastern Transvaal, 56 kilometers north of Rustenburg. Production of thorium as a byproduct may be possible. Assays indicated an average content of 3.16% ThO_2.[7]

Although the heavy minerals recovery plant of Palabora Mining Co. Ltd. at Phalaborwa, Transvaal, went on stream in 1971, technical details of the operation were not reported until 1972. Tailings from the copper concentrator are used as the raw material for heavy minerals production. The six modules of the heavy minerals plant correspond to the six sections of the copper concentrator. After desliming and removal of magnetite, the entire tail-

[2] Atomic Industrial Forum. New German Link Strengthens Gulf's European HTGR Alliances. Nuclear Ind., v. 20, No. 1, January 1973, pp. 36–37.
[3] Indian Rare Earths Ltd. 22nd Annual Report 1971–72, Bombay, 1972, pp. 32.
[4] Engineering and Mining Journal. V. 174, No. 1, January 1973, p. 148.
[5] American Metal Market. Ore Deposits in Indonesian Waters. V. 79, No. 139, July 28, 1972, pp. 14–15.
[6] Ministry of Industries. Review of Activities of Corporations 1971–72, pp. 53–57.
[7] South African Mining and Engineering Journal. Important Rare Earth Deposits in the Pilensburg. V. 84, No. 4068, May 1972, pp. 13–15.

ings output of the concentrator is processed through the plant. About 22,000 tons per day of dry solids represents the average quantity fed to the plant. Uranothorianite concentrate, obtained by gravity concentration and containing approximately 5% U_3O_8, 14% ThO_2, and 65% ZrO_2, was processed through the chemical extraction plant. Thorium and uranium are extracted by leaching with hot nitric acid. The liquor containing thorium and uranium is then treated in a solvent extraction circuit and the product calcined. A new feature of the process is the provision of facilities for recovery of nitric acid and thorium from the barren solution or raffinate from the solvent extraction. Since the ThO_2:U_3O_8 ratio is on the order 2.5:1, thorium could become an important byproduct.[8]

United Kingdom.—The United Kingdom Atomic Energy Authority won a contract to design and supply a solid moderator reactor (SMR) for the THTR under construction at Schmehausen in West Germany. The function of the SMR is to facilitate reloading of the THTR.[9]

Venezuela.—The Government announced a discovery of thorium in the Cerro Impacto Codesur area of southern Venezuela. The area was reserved for exploration by the State through a Government-owned corporation called Promocion Del Desarrollo Del Sur de Venezuela (Prodesur). Information on size of deposits and reserves was not reported.

TECHNOLOGY

Energy and metallurgical applications together with extraction techniques were the principal subjects of studies related to thorium during 1972. Most of the research was basic, and industrial utilization of results was not imminent.

Nonenergy.—At the Elliot Lake uranium mine in Ontario, Canada, large volumes of waste materials contain thorium. An investigation was conducted to find a solvent extraction process for the coextraction of uranium and thorium. The new approach would replace the present precipitation procedure for thorium elimination, which is costly because of neutralization and coprecipitation losses of the rare earths. Results indicated that high-purity thorium sulfate can be produced with the ion exchange-neutralization route. In addition, increased revenue would result if thorium is recovered.[10]

Metallurgical research was directed toward studies determining the effects of thorium and thorium compounds on physical and chemical properties of alloys, mostly high-temperature alloys, in different environments. One investigation indicated that addition of ThO_2 to high-temperature nickel or cobalt-base superalloys slows oxidation. In an oxidation process induced by Na_2SO_4, the presence of ThO_2 in a nickel-chromium alloy promoted selective oxidation of chromium, and the growth rate of the chromium oxide layer was approximately one order of magnitude less than that for growth of chromium oxide in simple nickel chromium alloys.[11]

The application of fine wires as high-strength structural components requires a better undertanding of differences of creep behavior. The creep properties of fine, recrystallized tungsten-thorium oxide (1% ThO_2 by weight) wires were studied over the temperature range 1,800° to 2,750° C. The creep behavior of tungsten-thorium alloy wire depends on grain structure, temperature, and stress. The study showed that the creep behavior of fine wires was not affected by geometry, and identical results could be expected for larger diameter specimens.[12]

Ronson Metals Corp.'s "CerAlloy 400," made of approximately 80% thorium, 15 mischmetal, and 5% aluminum, was used in plutonium-powered pacemakers (small devices, surgically implanted in body, regulating the rhythm of heart beat). The new pacemaker should operate for 10 years

---

8 Nel, V. Palabora's New Heavy Minerals Plant Adds Uranium Concentrate to the Recovery List. Eng. and Min. J., v. 173, No. 11, November 1972, pp. 186–187.

9 Chemistry and Industry. UKAEA Win Reactor Contract. No. 3, Feb. 5, 1972, p. 104.

10 Ritcey, H. C., and B. H. Lukas. Co-extraction of Uranium and Thorium. J. of Metals, v. 24, No. 4, April 1972, pp. 39–44.

11 David, H. H., H. C. Graham, and G. F. Uhlig. Oxidation of Na_2SO_4-Coated Ni-20Cr-2ThO_2. Met. Trans., v. 3, No. 12, December 1972, pp. 3247–3257.

12 Moon, D. M. Creep of Fine Wires of W-ThO_2 Alloys. Met. Trans., v. 3, No. 12, December 1972, pp. 3097–3102.

without change of power source, which is now necessary every 30 months.[13]

A dispersion-modified alloy containing thorium with nickel and chromium was under development for use in the space shuttle. Necessary properties of this alloy are high-strength, formability, and good oxidation resistivity at 2,200° F. Research indicated that a 2% to 5% addition of aluminum to the base alloy improved the oxidation resistance of the basic Ni-Cr-ThO system with a loss of strength at elevated temperatures.[14]

Th-Ni systems were studied over a composition range from 50% to 96% Ni and a temperature range of 1,000° to 1,500 C. Intermetallic compounds were observed that were not previously found. Alloys in this composition range were stable in air. A few alloys were annealed for 14 days at 800° C. Th-Ni alloys showed some similarities to Th-Si alloys.[15]

Work on optical absorption spectroscopy of ThO_2 was extended to purer specimens than those used previously. The fundamental absorption edge for these specimens lies at much higher energy than the apparent edge reported previously. A full analysis of certain crystals by spark-source mass spectrometry indicated that no strong correlation existed between specific band areas and impurity-element concentration. Moreover, purer specimen of fused ThO_2 revealed new, previously unobserved bands of the ThO_2 spectrum.[16]

Behavior of thorium-carbon alloys in a nitrogen environment at moderate pressures was examined. Results indicated an "uphill" (up a concentration gradient) diffusion of carbon in the ternary solid solution Th (C,N). This explains the tendency for carbon and thorium to segregate in the course of reaction of thorium carbon alloys with nitrogen at moderate pressures.[17]

Energy.—Effects of additives on the sintering of ThO_2 and ThO_2-Y_2O_3 compacted and loose powders were studied. The investigation showed that small amounts of nickel oxide are potent and increase the rate of sintering of thorium oxide, and the major portion of densification occurs very rapidly and is followed by a much slower process of sintering.[18]

A new HTGR concept was under investigation. GGA of San Diego, Calif., negotiated a contract with the Atomic Energy Commission (AEC) for design, engineering, and construction of a nuclear gas-turbine powerplant, which would eliminate the steam-turbine cycle by combining the HTGR with a closed-cycle helium gas-turbine generator. Hot helium at 1,500° C would turn the gas-turbine generator. Benefits of the new concept include savings in capital costs, improved reactor operating efficiency, and reduced environmental impact since lesser quantities of cooling water are needed.

The light water breeder reactor (LWBR) fuel is ThO_2 pellets in which 1% to 6% U_{233} in UO_2 form is dissolved. A project was underway to develop a chemical flowsheet for converting uranium-nitrate solution to ceramic grade UO_2 powder having desired properties for uniform blending with ThO_2 powder and for pressing and sintering to high-density fuel pellets for the LWBR.[19]

Solvent properties and corrosiveness of liquid sodium, which is used as a coolant in fast-breeder reactors, were the subjects of a study originating in Sweden. A system of corrosion in liquid metals is often accompanied with mass transfer of corrosion products, and alloys form within the bulk phase of the liquid metal. The Th-Cu system was studied in the temperature range of 200° to 700° C. Reaction products are finely divided and well crystallized at temperatures below the melting points. Sodium apparently does not participate as a catalyst in the process, but does promote

---

[13] Ruth, J. P. Rare Earth Metals Demand Up for Pipelines in Severe Areas. Am. Metal Market, v. 79, No. 130, July 17, 1972, p. 30.

[14] Baranow, S. The Effect of a Hydrogen Preheat-Treatment on the Oxidation Behavior of Ni-Cr-Al-ThO_2 Alloys. Met. Trans., v. 3, No. 12, December 1972, pp. 3265–3267.

[15] Tomson, J. R. Alloys of Thorium with Certain Transition Metals. VI. The Constitution of Thorium-Nickel Alloys Containing 50%–96% Nickel. J. Less-Common Metals, v. 29, No. 2, October 1972, pp. 183–188.

[16] Childs, B. G., P. J. Harvey, and J. B. Hallett. Optical Absorption Spectroscopy of ThO_2. J. Am. Ceramic Soc., v. 55, No. 11, November 1972, pp. 544–547.

[17] Benz, R. Nitride Layer Growth on Liquid Thorium and Solid Thorium Carbon Alloys. J. Electrochem. Soc., v. 119, No. 11, November 1972, pp. 1596–1602.

[18] Halbfinger, G. P., and M. Kolodney. Activated Sintering of ThO_2 and ThO_2-Y_2O_3 with NiO. J. Am. Ceramic Soc., v. 55, No. 10, pp. 519–524.

[19] Leitnaker, J. M., M. L. Smith, and C. M. Fitzpatrick. Conversion of Uranium Nitrate to Ceramic Grade for Light Water Breeder Reactor: Process Development. Oak Ridge National Laboratory, Metals and Ceramics Division, ORNL-4755, April 1972, p. 54.

the reaction by activating the cooper surfaces.[20]

In connection with the chemical processing of molten-salt breeder reactor (MSBR) fuels, information was sought on mutual solubilities of thorium and certain rare earth lanthanides in bismuth solutions over a temperature range of 350° to 700° C. Although individual solubilities of thorium bismuthides and most lanthanide bismuthides are known, few data are available on their mutual solubilities or the interractions of thorium, bismuth, and the lanthanides. For the study, the system was contained in an argon atmosphere in a molybdenum crucible. The components of the system interracted to form solid compounds.[21]

---

20 Berlin, B. Formation of the Intermediate Phases of the System Thorium-Copper in Liquid Sodium. J. Less-Common Metals, v. 29, No. 4, December 1972, pp. 337–348.

21 Smith, F. J. Mutual Interaction of Thorium, Lanthanides, and Bismuth in Th-Ln-Bi Solutions: Evidence for Formation of Th-Ln-Bi Compounds. J. Less-Common Metals, v. 29, No. 1, September 1972, pp. 73–79.

Tin

By Keith L. Harris [1]

Free world supply of tin exceeded consumption by about 7,000 long tons in 1972. World mine production of tin for 1972 was 239,602 long tons, up from 232,232 long tons in 1971. U.S. consumption of primary and secondary tin taken together decreased 1% for the year, with primary tin consumption increasing 3% and secondary consumption decreasing 14%. The major uses for tin were in solder, 32%; tinplate, 31%; bronze and brass, 14%; chemicals including tin oxide, 6%; and babbitt, 4%. Tin, as the mineral cassiterite (SnO_2), is mined and smelted at many places around the world, almost totally outside the United States. Most of the nation's tin, in the form of slabs, bars, and ingots, came from Malaysia and Thailand. Less than 100 long tons of tin were mined in the United States during the year, all from mines in Colorado and Alaska. About one-quarter of the tin used in the United States in 1972 was reclaimed from scrap in about 85 secondary smelters located across the country.

The only primary tin smelter-refinery currently operating in the United States is the Texas City, Tex., facility of Gulf Chemical and Metallurgical Corp. The smelter received 4,216 long tons of tin-in-concentrate from Bolivia's State-owned Corporacíon Minera de Bolivia (COMIBOL). In addition to concentrates, the smelter processed tin wastes for secondary recovery.

The Lost River Mining Corp., which has been conducting an evaluation of its fluorite-tin-tungsten deposit on Alaska's Seward Peninsula, has revised upward its tin reserves in one zone to just under 80,000 long tons. An additional 110,000 long tons have been claimed or indicated in two other zones of the property.

The General Services Administration disposed of no tin from the strategic stockpile through commercial channels, but 361 long tons were shipped to Turkey under programs of the Agency for International Development (AID).

The average New York price for prompt delivery of Straits (Malaysian) tin in 1972 was 177.469 cents per pound. This

[1] Physical Scientist, Division of Nonferrous, Metals.

Table 1.—Salient tin statistics

(Long tons)

	1968	1969	1970	1971	1972
United States:					
Production:					
Mine	W	W	W	W	W
Smelter	3,453	345	NA	4,000	4,000
Secondary	22,495	22,775	20,001	20,096	20,180
Exports (including reexports)	4,495	2,908	4,452	2,262	1,134
Imports for consumption:					
Metal	57,358	54,950	50,554	46,940	52,451
Ore (tin content)	2,439	---	4,667	3,060	4,216
Consumption:					
Primary	58,859	57,730	52,957	51,980	53,506
Secondary	23,102	23,060	20,880	17,970	15,527
Price: Straits tin, in New York, average cents per pound	148.111	164.435	174.135	167.344	177.469
World production:					
Mine	228,332	225,725	228,500	232,232	239,602
Smelter	229,564	225,290	223,696	231,901	236,185

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

represents a significant increase from 167.344 cents per pound in 1971.

The International Tin Council (ITC) at its regular quarterly meeting in July redetermined floor and ceiling prices for tin in the light of changes in exchange rates following the floating of the pound sterling. The market price of tin for purposes of buffer stock operations was to be expressed as the ex-works price on the Penang market.

Legislation and Government Programs.—No strategic stockpile tin was disposed of through commercial channels during the year. However, 361 long tons of tin were released to AID for shipment to Turkey. The stockpile objective remained at 232,000 long tons, and at the end of the year, there was an excess of 18,664 long tons on hand.

Government financial assistance on a participatory basis was available through the Office of Minerals Exploration (OME), U.S. Geological Survey, for tin exploration up to 75% of the allowable costs.

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 1972 was less than 100 long tons. Most of the year's output came from Colorado as a byproduct of molybdenum mining. Some tin concentrate was produced at dredging operations and as a byproduct of placer gold mining operations in Alaska. The Lost River Mining Corp., set up by Canada's P.C.E. Explorations to conduct operations at a fluorite-tin-tungsten property in the Lost River area of Alaska's Seward Peninsula, continued its feasibility study on mining and milling facilities for a 4,000-long-ton-per-day open pit mine projected to open by 1976. Reserves at the prospect area represent at least a 20-year supply. A $3 million share placement has been made to cover costs of the feasibility study. United States, Japanese, and Canadian firms have shown interest in long-term purchases and considerable financial assistance will be given by State and Federal agencies.

Smelter Production.—The only tin smelter in the United States is the Texas City, Tex., facility of Gulf Chemical and Metallurgical Corp. In 1972, it operated on Bolivian tin concentrate which formed the base load together with low-cost reclaimed domestic industrial residues to complete the feed. The smelter performed these functions as a contract toll converter for COMIBOL, and the resulting metal was then sold by COMIBOL to U.S. consumers. Thus, to all intents and purposes, U.S. tin consumers were wholly dependent upon foreign tin in 1972.

SECONDARY TIN

The United States is the world's leading producer of recycled, or secondary, tin. The United Kingdom, the Federal Republic of Germany, Austria, and Australia also produce secondary tin in significant quantities.

Of the tin recycled during 1972, 89% was an alloy constituent of bronzes,

Table 2.—Secondary tin recovered from scrap processed at detinning plants in the United States

	1971	1972
Tinplate scrap treated [1] ... long tons	742,259	714,960
Tin recovered in the form of—		
Metal ... do	1,786	1,494
Compounds (tin content) ... do	583	672
Total [2] ... do	2,369	2,166
Weight of tin compounds produced ... do	1,105	1,284
Average quantity of tin recovered per long ton of tinplate scrap used ... pounds	7.15	6.79
Average delivered cost of tinplate scrap ... per long ton	$28.78	$30.15

[1] Tinplate clippings and old tin-coated containers have been combined to avoid disclosing individual company confidential data.
[2] Recovery from tinplate scrap treated only. In addition, detinners recovered 551 long tons (494 tons in 1971) of tin as metal and in compounds from tin-base scrap and residues in 1972.

brasses, solders, and bearing and type metals. A small amount also remained in chemical compounds. Only about 11% of the recycled tin, mostly from new tinplate scrap, found its way to market as metal. This latter volume provided only 3% of the total tin supplied to U.S. consumers in 1972, a proportion which does not vary appreciably from year to year.

Secondary tin furnishes 27 to 30% of the total U.S. tin supply each year. However, secondary tin produced in this country was down in 1972 by 441 long tons.

Five companies in 11 States were engaged in the detinning business in 1972. Normally the raw materials used are tinplate scrap and spent chemicals or tinning solutions.

Table 3.—Tin recovered from scrap processed in the United States, by form of recovery

(Long tons)

Form of recovery	1971	1972
Tin metal:		
At detinning plants	2,250	2,001
At other plants	74	198
Total	2,324	2,199
Bronze and brass:		
From copper-base scrap	8,850	9,281
From lead and tin-base scrap	84	73
Total	8,934	9,354
Solder	5,482	5,213
Type metal	1,202	1,232
Babbitt	899	854
Antimonial lead	631	604
Chemical compounds	612	716
Miscellaneous [1]	12	8
Total	8,838	8,627
Grand total	20,096	20,180
Value (thousands)	$75,328	$80,222

[1] Includes foil, cable lead, and terne metal.

CONSUMPTION

Total consumption of tin metal decreased 1%, with primary tin consumption increasing by 3% and secondary tin consumption decreasing by 14%. Tin used in solder, up 11% from 1971, was the largest consuming sector in 1972. Although tin-

Table 4.—Shipments of metal cans [1]

(Thousand base boxes)

Type of can	1971	1972 p	1972 change (percent)
FOOD AND BEVERAGES			
Fruit and fruit juices	13,267	13,639	+2.8
Vegetables and vegetable juices	22,976	21,755	−5.3
Milk, evaporated and condensed	2,568	2,405	−6.3
Other dairy products	423	379	−10.4
Soft drinks	28,608	31,229	+9.2
Beer	39,168	44,379	+13.3
Meat and poultry	3,713	3,680	−0.9
Fish and other seafoods	2,510	3,185	+26.9
Coffee	3,671	3,595	−2.1
Lard and shortening	1,642	1,688	+2.8
Baby foods	1,510	1,462	−3.2
Pet foods	6,004	6,694	+11.5
All other foods, including soups	15,653	14,136	−9.7
Total	141,713	148,226	+4.6
NONFOOD			
Oils	3,085	3,095	+0.3
Paint and varnish	4,903	5,588	+14.0
Antifreeze	765	566	−26.0
Pressure packing (valve type)	5,285	5,877	+11.2
All other nonfood	6,139	6,552	+6.7
Total	20,177	21,678	+7.4
Grand total	161,890	169,904	+5.0
BY METAL			
Steel base boxes [2]	140,475	141,180	+0.5
Short tons (thousand)	5,552	5,592	+0.7
Aluminum base boxes	21,415	28,724	+34.1
Short tons (thousand)	449	e 600	+33.6

e Estimate. 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 5.—Stocks, receipts, and consumption of new and old scrap and tin recovered in the United States in 1972

(Long tons)

Type of scrap and class of consumer	Gross weight of scrap						Tin recovered		
	Stocks Jan. 1	Receipts	Consumption			Stocks Dec. 31	New	Old	Total
			New	Old	Total				
Copper-base scrap:									
Secondary smelters:									
Auto radiators (unsweated)	1,895	57,227	--	56,501	56,501	2,621	--	2,430	2,430
Brass, composition or red	3,107	74,078	17,346	56,401	73,747	3,438	570	2,096	2,666
Brass, low (silicon bronze)	580	3,338	2,596	719	3,315	603	--	6	6
Brass, yellow	4,873	58,248	7,146	51,320	58,466	4,655	29	517	546
Bronze	2,278	24,358	4,896	19,794	24,690	1,946	470	1,559	2,029
Low-grade scrap and residues	11,601	69,781	49,280	24,041	73,321	8,061	14	--	14
Nickel silver	463	3,302	477	2,718	3,195	570	4	20	24
Railroad-car boxes	304	2,434	--	2,422	2,422	316	--	115	115
Total	25,101	292,766	81,741	213,916	295,657	22,210	1,087	6,743	7,830
Brass mills:[1]									
Brass, low (silicon bronze)	r 3,284	34,017	34,017	--	34,017	5,838	1	--	1
Brass, yellow	14,292	297,632	297,632	--	297,632	15,154	244	--	244
Bronze	655	3,446	3,446	--	3,446	654	154	--	154
Nickel silver	3,254	25,891	25,891	--	25,891	4,990	--	--	--
Total	r 21,485	360,986	360,986	--	360,986	26,636	399	--	399
Foundries and other plants:[2]									
Auto radiators (unsweated)	842	9,200	--	9,160	9,160	882	--	413	413
Brass, composition or red	926	4,410	2,404	1,981	4,385	951	114	94	208
Brass, low (silicon bronze)	30	592	158	439	597	25	--	7	7
Brass, yellow	707	4,870	2,516	2,478	4,994	583	5	21	26
Bronze	240	506	227	344	571	175	18	26	44
Low-grade scrap and residues	414	628	371	498	869	173	--	--	--
Nickel silver	3	22	17	5	22	3	--	--	--
Railroad-car boxes	1,222	5,214	--	5,609	5,609	827	--	267	267
Total	4,384	25,442	5,693	20,514	26,207	3,619	137	828	965
Total tin from copper-base scrap	--	--	--	--	--	--	1,623	7,571	9,194
Lead-base scrap: Smelters, refiners, and others:									
Babbitt	r 314	9,836	--	9,865	9,865	285	--	479	479
Battery lead plates	r 36,113	454,206	--	455,230	455,230	35,089	--	485	485
Drosses and residues	r 18,224	140,632	141,858	--	141,858	16,998	2,976	--	2,976
Solder and tinny lead	r 258	8,910	--	8,763	8,763	405	--	1,360	1,360
Type metal	r 1,897	21,390	--	21,152	21,152	2,135	--	1,004	1,004
Total	r 56,806	634,974	141,858	495,010	636,868	54,912	2,976	3,328	6,304

Tin-base scrap: Smelters, refiners, and others:									
Babbitt	r 16	222	--	206	206	32	--	172	172
Block-tin pipe	r 12	144	--	141	141	15	--	139	139
Drosses and residues	r 427	3,803	3,495	--	3,495	735	1,644	--	1,644
Pewter	(3)	12	--	12	12	--	--	10	10
Total	r 455	4,181	3,495	359	3,854	782	1,644	321	1,965
Tinplate scrap: Detinning plants	--	--	714,960	--	714,960	--	2,717	--	2,717
Grand total	--	--	--	--	--	--	8,960	11,220	20,180

r Revised.
[1] Brass-mill stocks include home scrap; purchased-scrap consumption assumed equal to receipts; therefore, lines and total in brass-mill section do not balance.
[2] Omits "machine-shop scrap."
[3] Revised to none.

Table 6.—Consumption of primary and secondary tin in the United States

(Long tons)

	1968	1969	1970	1971	1972
Stocks Jan. 1 [1]	30,087	28,152	23,441	21,165	18,557
Net receipts during year:					
Primary	59,018	55,125	52,096	51,727	55,076
Secondary	2,101	2,325	2,502	2,491	5,766
Scrap	21,919	21,624	19,748	16,179	10,734
Total receipts	83,038	79,074	74,346	70,397	71,576
Total available	113,125	107,226	97,787	91,562	90,133
Tin consumed in manufactured products:					
Primary	58,859	57,730	52,957	51,980	53,506
Secondary	23,102	23,060	20,880	17,970	15,527
Total	81,961	80,790	73,837	69,950	69,033
Intercompany transactions in scrap	3,012	2,995	2,785	3,055	2,629
Total processed	84,973	83,785	76,622	73,005	71,662
Stocks Dec. 31 (total available less total processed)	28,152	23,441	21,165	18,557	18,471

[1] Stocks shown exclude tin in transit or in other warehouses on Jan. 1, as follows: 1968—20 tons; 1969—1,185 tons; 1970—80 tons; 1971—10 tons; and 1972—140 tons.

Table 7.—Tin content of tinplate produced in the United States

Year	Tinplate waste—waste, strips, cobbles, etc., gross weight (short tons)	Tinplate (all forms) Gross weight (short tons)	Tin content [1] (long tons)	Tin per short ton of plate (pounds)
1968	682,792	6,088,345	28,839	10.6
1969	581,594	5,944,758	26,886	10.1
1970	625,998	5,590,038	25,127	10.1
1971	547,959	5,297,970	23,669	10.0
1972	501,996	4,706,491	21,070	10.0

[1] Includes small tonnage of secondary tin and tin acquired in chemicals.

Table 8.—Consumption of tin in the United States, by finished product

(Long tons of contained tin)

	1971			1972		
	Primary	Secondary	Total	Primary	Secondary	Total
Alloys (miscellaneous)	425	169	594	468	441	909
Babbitt	1,977	1,187	3,164	2,206	890	3,096
Bar tin	826	16	842	780	116	896
Bronze and brass	3,013	8,010	11,023	3,095	6,546	9,641
Chemicals including tin oxide	1,924	1,716	3,640	2,462	1,568	4,030
Collapsible tubes and foil	721	12	733	790	16	806
Pipe and tubing	19	5	24	W	W	W
Solder	13,947	5,812	19,759	16,896	4,951	21,847
Terne metal	249	128	377	192	40	232
Tinning	2,238	56	2,294	2,532	79	2,611
Tinplate [1]	23,669	--	23,669	21,070	--	21,070
Tin powder	1,513	19	1,532	1,150	--	1,150
Type metal	90	730	820	103	737	840
White metal [2]	1,345	102	1,447	1,579	138	1,717
Other	24	8	32	183	5	188
Total	51,980	17,970	69,950	53,506	15,527	69,033

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 jewelers' metal.

plate was the largest consuming sector of primary tin (39%), the amount of total tin used for this purpose failed to be the largest domestic end-use for the first time since 1945. A 24% increase in imports of tinplate of which Japan furnished 56%, and a very small increase in shipments of steel-based cans resulted in an 11% decrease in U.S. tinplate production. An increase of over 34% in shipments of aluminum cans contributed in part to the lower consumption rate of tinplate. Consumption of tin in bronze and brass (down 13%) and babbitt (down 2%) continued the decline of the past several years. Compared with 1971 figures, the use of tin increased in alloys, bar tin, chemicals, collapsible tubes and foil, solder, tinning and white metal, while consumption for type metal was essentially unchanged. Tin consumption by U.S. brass mills was 1,426 long tons of primary tin compared with 1,065 long tons in 1971. Consumption of secondary tin, at 501 long tons, was down somewhat from the 1971 total of 545 long tons.

STOCKS

Tinplate mills, which at yearend held 65% of the plant stocks of pig tin, were the largest users of primary tin. Stocks of pig tin rose to the year high of 9,565 long tons at the end of January in anticipation of a possible dock strike in February. Stocks dropped after the strike failed to materialize. An upward trend was evident for the remainder of the year with yearend stocks of pig tin recording a 7% rise from 1971 figures reversing the downward trend in evidence since 1965. Tin in process and tin afloat recorded slight declines from 1971 but stocks held by jobbers and importers rose 67% resulting in an increase of 2% in total industrial stocks.

Table 9.—U.S. industry yearend tin stocks

(Long tons)

	1968	1969	1970	1971	1972
Plant raw materials:					
Pig tin:					
Virgin	15,975	12,281	9,451	7,779	8,149
Secondary	215	253	222	255	452
In process [1]	11,962	10,907	11,492	10,523	9,870
Total	28,152	23,441	21,165	18,557	18,471
Additional pig tin:					
In transit in United States	1,185	80	10	140	445
Jobbers-importers	1,182	1,210	1,635	1,630	2,720
Afloat to United States	5,390	5,865	3,500	4,510	3,725
Total	7,757	7,155	5,145	6,280	6,890
Grand total	35,909	30,596	26,310	24,837	25,361

[1] Tin content, including scrap.

PRICES

The average price for prompt tin metal, at £1505.94 per metric ton, was higher on the London Metal Exchange (LME) than the average 1971 price. Prices were buoyed in midyear by the floating of the pound sterling. Prices on the Penang and New York markets retreated from high midyear prices as an ITC forecast of a deficit of 3,500 long tons in production changed to an actual surplus of 7,000 long tons by yearend. On both markets, prices in December 1972 were about the same as in January 1972. The average Penang price for ex-works Straits tin in 1972 was M$626.80 per picul (one picul = 133.33 pounds), and the average New York price for prompt Straits tin was 177.469 cents per pound.

After dull trading conditions early in the year on the Penang market, the revival of consumer demand to replenish stocks moved prices to the high of the year of M$655.50 per picul on March 24. Prices then deteriorated through August when

ITC buffer stock support held the prices at the M$622.00 per picul level. Consumer demand picked up after summer stocks were worked off and prices rose moderately from late August through September. Prices fell to the low of M$605.00 per picul in mid-November after which they recovered to end the year at M$629.00 per picul.

Table 10.—Monthly prices of Straits tin for prompt delivery in New York

(Cents per pound)

Month	1971 High	1971 Low	1971 Average	1972 High	1972 Low	1972 Average
January	162.250	161.000	161.638	172.000	170.500	171.310
February	164.500	161.250	162.855	174.000	171.000	172.000
March	170.000	163.250	167.011	183.750	175.000	179.810
April	170.500	168.000	168.881	183.000	181.000	181.975
May	168.500	164.000	166.025	180.000	175.250	177.920
June	165.750	163.750	164.477	176.250	173.500	175.034
July	167.500	165.500	166.440	177.750	175.000	176.613
August	167.500	165.000	166.074	182.250	177.500	179.120
September	167.500	166.750	167.286	182.750	181.000	181.988
October	168.500	167.250	167.697	182.000	178.000	180.400
November	177.250	168.750	175.388	178.250	176.250	177.213
December	177.500	172.000	174.357	178.500	174.750	176.250
Average	177.500	161.000	167.344	183.750	170.500	177.469

Source: American Metal Market.

FOREIGN TRADE

The United States continued to rely upon foreign sources for tin. Malaysia furnished 62% of the tin imported into the United States; Thailand, 22%; and Australia and Indonesia, combined, 8%.

During 1972, 4,216 long tons of tin-in-concentrate were imported from Bolivia for smelting at the Texas City, Tex., smelter.

Exports from the United States were 1,134 long tons.

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 volumes find their way into consumption figures and account for the differences normally encountered between U.S. production and consumption of secondary tin. Tin that is a constituent alloy in imports and exports of babbitt, solder, type metal, and bronze is 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 11.—U.S. exports and imports for consumption of tin, tinplate, and terneplate in various forms

Year	Ingots, pigs, and bars: Exports Quantity (long tons)	Ingots, pigs, and bars: Exports Value (thousands)	Ingots, pigs, and bars: Reexports Quantity (long tons)	Ingots, pigs, and bars: Reexports Value (thousands)	Tinplate and terneplate: Exports Quantity (long tons)	Tinplate and terneplate: Exports Value (thousands)	Tinplate and terneplate: Imports Quantity (long tons)	Tinplate and terneplate: Imports Value (thousands)	Tinplate circles, strips and cobbles (Exports) Quantity (long tons)	Tinplate circles, strips and cobbles (Exports) Value (thousands)	Tinplate scrap (Imports) Quantity (long tons)	Tinplate scrap (Imports) Value (thousands)
1970	4,009	$15,222	443	$1,701	294,788	$59,458	292,611	$59,066	21,348	$2,628	19,382	$591
1971	1,821	6,648	441	1,620	186,151	39,605	372,875	80,562	8,675	1,186	18,071	546
1972	857	2,915	277	1,055	245,355	51,929	466,455	107,844	4,076	522	15,214	437

Table 12.—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.			Miscellaneous tin and manufactures: Exports: Tin scrap and other tin bearing material, except tinplate scrap	Tin compounds: Imports	
		Dross, skimmings, scrap, residues, and tin alloys, n.s.p.f.				
	Value (thousands)	Quantity (long tons)	Value (thousands)	Value (thousands)	Quantity (long tons)	Value (thousands)
1970	$4,311	776	$275	$2,466	272	$817
1971	r 4,472	4,125	1,385	1,780	91	257
1972	6,501	1,304	2,140	3,392	152	477

r Revised.

Table 13.—U.S. imports for consumption of tin,[1] by country

Country	1971 Quantity (long tons)	1971 Value (thousands)	1972 Quantity (long tons)	1972 Value (thousands)
Argentina	50	$176	--	--
Australia	1,116	3,500	2,184	$7,468
Belgium-Luxembourg	16	64	71	277
Bolivia	864	3,095	1,104	4,172
Brazil	167	583	696	2,620
Canada	240	864	274	1,067
Chile	269	980	93	354
China, People's Republic of	--	--	160	639
France	--	--	20	73
Germany, West	--	--	99	359
Hong Kong	--	--	20	73
India	35	120	175	650
Indonesia	1,420	5,592	1,997	8,126
Japan	--	--	25	91
Malaysia	27,746	96,950	32,645	120,780
Netherlands	25	94	163	451
Nigeria	306	313	184	691
Peru	165	593	128	492
Singapore	24	91	129	469
Taiwan	15	55	86	324
Thailand	13,861	49,126	11,727	44,393
United Kingdom	621	2,207	471	1,852
Total	46,940	164,403	52,451	195,421

[1] Bars, blocks, pigs, grain, or granulated.

WORLD REVIEW

INTERNATIONAL TIN AGREEMENT

The International Tin Council (ITC) operating under the Fourth International Tin Agreement, had an active year in the face of surplus tin production, sluggish demand, an unstable monetary base and low tin prices. Production of tin-in-concentrate exceeded consumption of tin by about 7,000 long tons. Prices of tin remained in the lower sector of the buffer stock operating range except for several months in the first half of the year when prices moved into the middle sector.

At its March meeting, the ITC announced that on December 31, 1971, the buffer stock contained 6,532 long tons of tin metal. In addition, Taiwan withdrew from membership and the consumer member votes were reallocated.

After the floating of the pound sterling by the British Government on June 23, the ITC at its July meeting temporarily changed the currency base for the operation of the buffer stock from terms of pound sterling per metric ton to terms of the ex-works price of tin on the Penang market as expressed in Malaysian dollars per picul.[2] The redetermined floor and ceiling prices and sectors of the price range, which approximated the former price range were as follows:

	M$ per picul ex-works Penang
Floor price	583
Lower sector	583–633
Middle sector	633–668
Upper sector	668–718
Ceiling price	718

The votes of the consuming countries, as established at the July meeting, effective July 1, 1972, were as follows:

	Votes
Japan	216
United Kingdom	141
Germany, West	115
France	90
Italy	60
U.S.S.R.	56
Netherlands	46
Canada	41
India	40
Poland	37
Czechoslovakia	32
Belgium-Luxembourg	29
Spain	28
Yugoslavia	16
Hungary	15
Denmark	11
Austria	10
Bulgaria	10
Korea, Republic of	7
Total	1,000

The buffer stock was reported to contain 7,971 long tons of tin metal on March 31, 1972. The first quarter installment from the consuming countries to the buffer stock of the equivalent of 2,461 long tons was paid. The first voluntary contribution to the buffer stock from a consuming country of $1.6 million was accepted from the Netherlands, and the French Government served notice that it intended to make a voluntary contribution to the buffer stock. Also, an outline report on arrangements for a proposed conference on tin to be held in the fall of 1974 at Kuala Lumpur, Malaysia, in conjunction with the Tin Research Institute (TRI) and the Malaysian Government was presented.

The ITC held a special session in August in London to discuss the possibility of imposing export controls and to request additional financial support for the buffer stock to stem the declining tin prices. The ITC rejected export controls in favor of additional support for the buffer stock in the form of an immediate callup of 4,921 long tons of tin metal or its cash equivalent from the producing nations. The ITC also granted the executive chairman authority to call up the remaining 2,461 long tons of tin metal from the 19,684 long ton aggregate compulsory contribution without the need of convening a special meeting of the Council. Support of the buffer stock proved costly for two of the members, Indonesia and Nigeria, who were forced to borrow from the International Monetary Fund (IMF).

The sixth session of the ITC was held in Djakarta, Indonesia, October 3-6. Floor and ceiling prices and sectors of the price range were reviewed and retained as established at the July meeting. Votes of the producing countries were revised and became effective October 1, as follows:

	Votes
Malaysia	441
Bolivia	181
Thailand	132
Indonesia	119
Nigeria	50
Zaire	43
Australia	34
Total	1,000

The Council again decided not to apply export controls but to arrange for a $20.8 million standby credit facility from the IMF for buffer stock purposes. Buffer stock levels for June 30 and October 5 were 7,991 and 9,971 long tons, respectively. Continuing buffer stock support for the fourth quarter failed to bring the price of tin out of the lower sector of the buffer stock operating range. Buffer stock holdings at the end of December were not revealed but they were probably about double the 6,532 long tons held on December 31, 1971. This large buildup during the year offered continued impetus to the feelings that buffer stock operations would have to be supplemented with export controls early in 1973 to move the price into the middle sector.

A conference on the consumption of tin, jointly sponsored by the ITC and the TRI was held in London in March. Seventeen tin-consuming and six tin-producing nations were represented at the 7-day conference. Papers were presented discussing tinplate and the availability, properties, marketing, and uses of tin.

Australia.—Associated Tin Smelters Pty. Ltd. increased the capacity of Australia's only tin smelter at Alexandria, New South

[2] One Malaysian dollar (M$) = US$0.355, one picul = 133.33 pounds.

Wales, by 50% to 15,000 long tons per year of concentrate. The expansion is part of a 5-year plan to keep pace with increasing mine production and to produce more metal within the country. Most of the exported concentrate was smelted in Malaysia and the United Kingdom.

Renison Ltd., Australia's largest tin producer, has increased its proven ore reserves to 7,149,000 long tons with an estimated tin content of 1.3%. The Aberfoyle group, consisting in part of Aberfoyle Tin Co. N.L., Ardlethan Tin N.L. and Cleveland Tin N.L., reported a mid-year total of 7,843,000 long tons of measured, indicated, and inferred ore reserves. Cleveland Tin N.L. reported an overall drop in recovery rate at their newly commissioned flotation plant from 69.3% to 67.2% because of higher throughput rates, which resulted in intense loading of individual sections.

Tableland Tin Dredging N.L. rebuilt its dredge at Upper Return Creek, Mount Garnet, Queensland. The area leased at Upper Return Creek is reported to encompass 10 million cubic yards calculated to contain 2,550 long tons of cassiterite. Upon completion of these leases, the dredge will be moved to Lower Return Creek where proven reserves of 13.25 million cubic yards containing about 2,400 tons of cassiterite are available.

Minerals Recovery (Australasia) N.L. is involved in five separate mining operations over the 16-mile stretch of its Vegetable Creek-deep lead prospect near Glen Innes, New South Wales. A 30-cubic-yard-per-hour plant at its Sugarloaf open pit mine and a 100-cubic-yard-per-hour plant at its Foleys open pit mine were commissioned. Loloma Mining Corp.'s Irvinebank tin operation in North Queensland commenced continuous milling in April. Treatment capacity was projected at 65,000 long tons per year. Gippsland Minerals N.L. and Cominco Exploration gave inferred ore reserves at their jointly held Queen Hill, Zeeham, Tasmania property as 1 million long tons of 1.4% tin and 200,000 long tons of 0.8% tin.

Bolivia.—Of the 31,056 long tons of tin-in-concentrate produced in 1972, COMIBOL contributed 21,246 long tons, the medium miners 5,832 long tons, and the small miners 3,978 long tons. COMIBOL'S marketable tin output, up 6.3% from that of 1971, originated mainly from ore containing 0.76% tin, but also included purchases from independent small miners and from lessees and cooperative organizations working COMIBOL'S small mines, and tin as a volatilization product from several plants. COMIBOL'S costs to produce and market tin continued to rise, reaching $1.61 per pound in 1972 compared with $1.58 in 1971 and $1.50 in 1970. After the Bolivian currency devaluation of October 27, 1972, the costs in November and December decreased to $1.37 and $1.30, respectively. However, a new 20% tax on the value of exported tin imposed at the time of devaluation added 19 cents to the cost. The most important COMIBOL mine, Siglo XX, which produced about 32% of COMIBOL'S tin output, reportedly is running out of low-grade tin mineralized blocks which it mines by block-caving methods. This mine's largest tin reserve exists in its mill tailings.

Total tin exports were 30,087 tons, the largest tonnage of tin exported since 1953 when 34,824 tons were exported. The Empresa Nacional de Fundiciones (ENAF), the national smelting company, decreased its metallic tin exports from 6,706 tons in 1971 to 6,200 tons in 1972, but the value was about the same as that of 1971 exports because of increased prices.

Early in the year COMIBOL and International Metal Processing Corp. (IMPC) agreed to form a joint venture company Empresa Metalúrgica Boliviana S.A. (EMBOSA) to operate the tin tailings concentration plant at Catavi with COMIBOL owning 55% of EMBOSA and IMPC 45%.

COMIBOL estimated its ore reserves at about 300,000 tons of contained tin as of January 1, 1972. These reserves do not include alluvial deposits, or tailings and dump materials that may be processed in the future.

Representatives from Klöckner-Humboldt-Deutz of West Germany and ENAF discussed plans to increase the annual capacity of the Vinto smelter from 7,400 tons to 19,700 tons, but no final decision was reached. In December it was reported that the planned capacity had been reduced to 10,800 tons because of the high estimated cost for the larger smelter. ENAF has operated the plant for 2 years but has not overcome the problem of low tin recovery. In addition to ENAF's smelter there are two small tin smelters in Oruro; the Pero smelter which was returned to the Pero family by COMIBOL late in 1972 and Metalúrgica Oruro. Both smelters produce a volatilization product. Another small smelter, Hormet, in La Paz produced a very small amount of metallic tin.

Michimen Co., Ltd., and Senju Metal Industry Co. of Japan signed a contract with ENAF to buy 590 long tons of electrolytic tin as a trial purchase to estimate the market. If successful, Japan will consider establishing a tin industry in one of the Andean Pact countries using Bolivian electrolytic tin.

The General Manager of COMIBOL signed agreements in the U.S.S.R. for the installation of a tin volatilization plant at Potosí and an $8 million loan for mining equipment. Plans called for plant construction to begin in April 1973 with completion by June 1974. It was also agreed to examine the possibility of installing at a later date tin volatilization plants in Oruro and Quechisla.

Brazil.—Twelve different groups, including 96 different companies, have applied for permission to prospect and mine the cassiterite deposits in Rondônia. Mineração Aracazeiro, Mineração Brumawdinho, and NL Industries, Inc., will jointly mine property in the upper Candeias River basin. An initial reserve of 10,000 long tons of tin has been established in the 74,130-acre

Table 14.—Tin: World mine production by country [1]

(Long tons)

Country	1970	1971	1972 p
North America:			
Canada	118	142	161
Mexico	r 525	471	348
United States	W	W	W
South America:			
Argentina	1,153	700	1,000
Bolivia [2]	r 28,944	29,533	31,056
Brazil	3,553	e 3,200	2,769
Peru (recoverable)	r 101	166	130
Europe:			
Czechoslovakia	163	166	157
France	332	344	308
Germany, East e	[3] 1,000	[3] 1,000	1,000
Portugal	428	546	365
Spain	436	396	193
U.S.S.R.	27,000	28,000	28,000
United Kingdom	1,695	1,787	3,274
Africa:			
Burundi	48	e 50	e 50
Cameroon	35	22	e 20
Congo (Brazzaville) e [4]	r 47	r 47	47
Morocco	r 17	8	8
Niger	66	67	67
Nigeria	7,833	7,210	6,625
Rhodesia, Southern e	600	600	600
Rwanda e	1,300	1,300	1,300
South Africa, Republic of	r 1,979	1,997	2,125
South West Africa, Territory of [5]	r 1,133	949	979
Swaziland e [4]	12	12	12
Tanzania	104	113	31
Uganda	120	129	79
Zaire	6,356	e 6,400	e 6,400
Asia:			
Burma	r 428	672	732
China, People's Republic of e	20,000	20,000	20,000
Indonesia	18,761	19,411	20,992
Japan	780	777	859
Korea, Republic of	--	5	1
Laos	r 679	774	e 815
Malaysia	72,630	74,253	75,617
Thailand	21,435	21,346	21,717
Oceania: Australia	r 8,689	9,639	11,765
Total	r 228,500	232,232	239,602

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 exports.

[3] Estimate according to the 59th annual issue of Metal Statistics (Metallgesellschaft).

[4] Estimate by International Tin Council.

[5] Data presented are for years ending June 30 of that stated.

Table 15.—Tin: World smelter production by country [1]

(Long tons)

Country	1970	1971	1972 p
North America:			
Mexico	525	471	348
United States [2]	W	4,000	4,000
South America:			
Bolivia [3]	301	7,116	6,405
Brazil	r 3,156	e 3,212	3,526
Europe:			
Belgium	4,190	3,878	3,861
Germany, East e	r 4 1,100	4 1,100	1,000
Germany, West	1,176	1,151	845
Netherlands	5,843	824	--
Portugal	r 386	476	597
Spain	r 3,846	4,584	4,206
U.S.S.R. e	27,000	28,000	28,000
United Kingdom	21,687	22,787	20,996
Africa:			
Morocco e	12	12	12
Nigeria	7,942	7,243	7,405
Rhodesia, Southern e	600	600	600
South Africa, Republic of	603	703	767
Zaire	1,374	e 1,330	e 1,400
Asia:			
China, People's Republic of e	20,000	20,000	20,000
Indonesia	5,108	9,074	11,819
Japan	1,356	1,355	1,329
Laos	621	696	e 700
Malaysia [5]	r 90,049	85,719	89,564
Thailand	21,692	21,337	21,889
Oceania: Australia	5,129	6,233	6,916
Total	r 223,696	231,901	236,185

e Estimate. p Preliminary. r Revised.

[1] Data derived in part from the Statistical Bulletin of the International Tin Council, London, England.

[2] Includes tin content of alloys made directly from ores.

[3] Tin content of production from Metabol and Pero smelters plus exports by ENAF smelter.

[4] Estimate according to the 59th annual issue of Metal Statistics (Metallgesellschaft).

[5] Includes small production of tin from the smelter in Singapore.

area allotted to this group of companies for exploration. Two additional areas at Garcas and Candeias are being prospected for their reserve potential. The tin will be mined with a mobile excavating plant at a monthly production rate of 100 long tons of tin concentrate.

Canada.—Ecstall Mining, Ltd. a subsidiary of Texas Gulf, Inc., proved the feasibility of tin recovery from zinc tailings at its Kidd Creek mine near Timmins, Ontario. The new tin recovery circuit will go into operation late in 1973 with an expected recovery rate of 1.5 million pounds of tin per year. The Sullivan Mining Group reported discovery of a large mineralized area in Brunswick Tin's North-Zone in addition to the already defined Fire Tower Zone to the south.

Indonesia.—A contract for the expansion of the Peltim smelter at Muntok has been signed with Paul Bergsoe & Son of Glostrup, Denmark, in partnership with S. C. Pearce & Associates of Southport, Lancashire, United Kingdom. The agreement calls for improving the performance of the three existing rotary furnaces, and the construction of three stationary furnaces to increase total smelter capacity to about 27,500 long tons of refined tin per year. Trial runs are expected to begin in mid-1974.

Foreign investors are welcome in tin mining and the Government has opened the following areas for exploration and development: northern part of Riau Archipelago, excluding Karimun and Kundur; southern part of the Riay Archipelago, except Singkep; the open sea between Singkep and Bangka Island; selected areas on Bangka and Bilitung areas around Karimata; and some land group areas of Bangkinang on Sumatra.

A loan from the Netherlands was of great assistance to the program of modernizing and rehabilitating Indonesia's fleet of bucket dredges. The Mining & Transport Division (MTD) of IHC Holland of Rotterdam undertook the project to modernize three small bucket dredges, namely Klantji, Lais, and Rajah. The 9-cubic-foot dredge Klantji was the last of the steam-fired dredges, and the 7-cubic-foot dredges, Lais and Rajah, were the oldest of Indonesia's fleet of 30-tin dredges. Electrification of the Rambat and Templiland dredges doubled their capacity.

Overseas exploration companies continued their prospecting. P.T. Koba Tin was prospecting on Koba Island and the offshore areas. P.N. Timah and N.V. Billiton Maatschappij were prospecting off Air Kantung to depths of 250 feet. Billiton holds two concessions: Karimata, southwest of Kalimantan, and Pulau Trudju off the east coast of Sumatra.

Bluemetal Industries Ltd. of Australia completed negotiations with the Indonesian Government regarding tin mining on Bangka Island where substantial new reserves have reportedly been proved.

Malaysia.—Malaysia continued to lead the world in production and smelting of tin in 1972. A total of 75,617 long tons of tin-in-concentrate was mined, the highest output in 31 years. At yearend there were 56 tin dredges, 940 gravel pump mines, and 46 opencast, underground, and other miscellaneous mines in operation, a slight decrease compared with 1971 figures.

Gravel pump operations, worked for the most part by the same families that own the mines, accounted for about 55% of the concentrate produced, while dredging by corporations furnished another 32%. Opencast mines brought in 4% of the ore produced; underground mines accounted for 3%; and the remaining 6% came from miscellaneous sources. Metal production, at 89,564 long tons, was 4% above the 1971 level of 85,719 long tons and the largest amount of tin refined since 1941.

The Malaysian Government opened up 86,000 acres of virgin land in West Malaysia for tin exploration. The 40,000-acre site in the state of Johore, 36,000 acres in Pahang and 10,000 acres in Perak have unknown tin value but the Malaysian Government was confident that rich deposits would be uncovered.

Berjuntai Tin Dredging Berhad, the largest tin dredging operator in the world, increased its tin concentrate output by 714 long tons to a record of 4,917 long tons in its fiscal year ending April 30. This output is the second highest recorded of any private tin mining company in the world. Berjuntai dredges in an area about 20 miles from Kuala Lumpur on the Selangor River.

The Pehang Consolidated Co. Ltd., Malaysia's only significant lode tin producer, reported an output of 2,632 long tons of tin concentrate averaging 71.1% tin during its fiscal year ended July. Further expansion of production at the Sungei Lembing mine, principally for improvements in mining and dressing equipment and expenditures on the Gakak shaft, has been announced.

State and private interests have drawn plans to locate four new dredges in Selangor. Two dredges are planned by the Selangor State Development Corporation for a 1,000-acre site at Ulu Langat; one is planned by Petaling Tin Berhad at Kuala Langat; and Berjuntai Tin Dredging Berhad considered replacement of its 35-year-old No. 1 dredge with a new and more modern plant.

Pernas, the Malaysian state corporation, has been granted exploration rights for tin off the west coast of West Malaysia along the states of Selangor, Perak, and Penang. Pernas began a soil study in the Johore River estuary, covering 12,600 acres, using seismic profiling and core sampling to produce a geochemical map that would indicate areas for final evaluation.

Malaysia, Indonesia, and Thailand signed an agreement to draw up continental shelf boundaries in the northern part of the Straits of Malacca. The agreement will not isolate areas of seabed for exploration but will promote joint efforts in exploring areas of potential wealth for mutual benefit.

Kuala Lumpur has been chosen as the headquarters of the Tin Industry Development and Research Center for Southeast Asia. The functions of the Center would include the investigation of problems relevant to exploration, evaluation, and exploitation of the area's tin deposits. A determination of the requirements of the Center will be conducted under the auspices of the United Nations Development Program, which will assist in the establishment of the Center.

Nigeria.—Production of tin in Nigeria declined to 6,625 long tons, its lowest level since 1959. Rising costs of production, lower quality ore bodies and declining world prices all contributed to the low output. One of the declared aims of Nigeria's National Development Plan (1970–74) was fulfilled by the creation of a national mining body, the Nigerian Mining Corp. The corporation will engage in prospecting, mining, and refining of all minerals other than coal and petroleum. The Nigerian Government also set aside about $7 million for the mining sector during the current development plan to increase exploration of tin and other minerals. A wholly owned Nigerian mining company, the United Nigeria Miners Co. Ltd., formed by the All-African Miners Association, will be established in Jos to focus on tin mining. Gold and Base Metal Mines, Ltd., may become the first lode tin mining operation in Nigeria. Initiation of the operation is contingent upon the satisfactory outcome of discussions with the Nigerian Government. The company's Liruie lode, located in Kano State, Northern Nigeria, is expected to provide 600 long tons of ore per day to yield about 1,000 tons of tin concentrate per year. Indicated ore reserves were 2 million long tons. If the anticipated production rate materializes, the company would be second only to Amalgamated Tin Mines of Nigeria Ltd. in tin concentrate output. Amalgamated Tin Mines reported production of 3,720 long tons of tin concentrate for 1972, up 0.5% compared with 1971.

South Africa, Republic of.—New flotation plants were commissioned by both major South African tin companies. Rooiberg Minerals Development Co. Ltd. installed flotation equipment at their "A" mine concentrator in the Warmbaths district of Transvaal. Monthly production of tin in low-grade flotation concentrate increased to about 18 long tons by the end of the year. A production increase of nearly 4% to 1,480 long tons was reported by Rooiberg for its fiscal year ending June 30. Union Tin Mines Ltd. reported that the second stage of its two-stage flotation plant will increase its monthly recovery rate to at least 20 long tons of tin in flotation concentrate.

Thailand.—Thailand's Mineral Resources Department reported that 620 tin mines were in operation at the beginning of 1972. Of the total, there were 22 dredges (16 inland, 6 offshore), 263 gravel pumps, 16 hydraulic mines, 112 ground sluicing operations, 176 tin-tungsten operations, and 31 unspecified operations.

The largest U.S. firm with interests in Thai tin was Union Carbide Corp., which operates in Thailand through two partially owned subsidiaries, Thailand Exploration and Mining Co., Ltd. (Temco) and Thailand Smelting and Refining Co., Ltd. (Thaisarco). N. V. Billiton Maatschappij of the Netherlands owns 50% of Thaisarco and 40% of Temco. Thaisarco, which operates the only tin smelter in Thailand, experienced a 4-week breakdown in one furnace while another furnace was being renovated. Total tin metal production was not affected by the breakdown of the Phuket smelter, which reported about a 3% increase in metal production compared with 1971.

Temco's suction cutter dredge, the Temco II, which began seabed mining between Phuket Island and Tai Muang, and its smaller sister dredge Temco I, are expected to raise Temco's metal output to 1,000 long tons per year.

Satisfactory results for two other offshore dredging companies operating in Thailand have been reported. Aokam Tin Berhad's two dredges, currently recovering about 2,000 long tons of 76% tin concentrate per year, operated on the Bang Tao Bay property from November to April, and on the Phuket Bay property for the other months. Ore reserves at both areas are expected to be depleted in about 15 years. Tongkah Harbour Tin Dredging Berhad's sea dredge produces over 900 long tons of concentrate. Reserves are said to be sufficient for the life of the existing plant.

Pacific Tin Consolidated Corp., another U.S.-owned corporation in Thailand, in a joint venture with Thai Tin and Tungsten Corporation, reported satisfactory progress on the preliminary development of an underground mine near Sichon. Adits, drifts, and surface exposures have shown grades on the order of 1.4% tin in widths averaging about 7 feet.

Singapore.—The Straits Trading Co's. Pulau Brani smelter, which began refining tin in Singapore in 1890, closed down. In recent years, Pulau Brani has been treating imported tin slags until the Straits Trading Co. was advised that the site was required for further expansion of port facilities.

U.S.S.R.—The U.S.S.R. announced completion of a major tin ore dressing plant located in the Sikhote Alin Mountains, in the southern region of the Soviet Far

East. The plant will produce metal from previously discarded materials provided by more than 500 tin ore deposits in the area. An ore dressing complex at Khrustalninsk in the Soviet Far East produced a high quality tin concentrate (80% tin content) with the aid of chemicals.

United Kingdom.—Wheal Jane Ltd., a subsidiary of Consolidated Gold Fields, Ltd., produced tin metal at an annual rate of about 1,800 long tons, approximately 400 long tons over its initial target rate. Modifications of the treatment plant considerably reduced high tin losses experienced during startup. Deepening and reequipping of the Clemow shaft, to be completed early in 1973, will allow the treatment plant to operate at full capacity.

TECHNOLOGY

A new process for extracting tin from low-grade complex ores, iron-tin alloys, mattes, drosses, and slags has been developed.[3] The process using a feed containing at least 3% tin, allows the separation and recovery of the lead and iron fraction and recovery of at least 95% of the tin.

A process was patented in West Germany on an improved and cheaper chlorine volatilization process for recovering tin from ore, concentrate, or slag.[4] Calcium chloride and carbon are used in a high throughput method to form tin chloride. The gases are passed through water yielding tin oxide, hydroxide, or oxychloride. The calcium chloride is recovered and reused to briquet the input tin material.

A radioisotope X-ray fluorescence method is being used to monitor the tin content of the tailings streams at the Geevor mine in Cornwall.[5] Its basic techniques are said to be applicable to all mineral dressing plants.

A new tin oxide for polishing plastic lenses and other plastic specialties has been developed by M & T Chemicals, Inc.[6] The company claims the tin oxide polishes up to 40% faster and at 33% less cost than other available polishing materials. The firm has also developed a low-cost acid tin plating process which produces a brilliant through satin range of coatings.[7] Another development in the plating industry has been a bright tin-lead plating process which is of particular value in the electronics industry.[8] Several proprietary processes using various types of brighteners, surface active agents, and antioxidants produce a bright tin-lead coating over a wide range of current densities and temperatures.

It was found that sintering austenitic stainless steel (18% chromium, 10% nickel) with tin powder improved its tensile strength but reduced its ductility slightly.[9]

Tin powder particle size distribution had no effect on the sintering behavior of iron compacts containing 2% tin—3% copper but reduced the tensile strength of iron compacts containing 1% tin—1.5% copper.[10]

The British Cast Iron Research Association described how additions of tin can be made to cast iron to improve tensile strength and hardness.[11] The first International Standard was defined for electroplated coatings of 65/35 tin-nickel alloy on steel or iron, copper and copper alloys or zinc alloys.[12] The standard prescribes required coating thickness for various degrees of service conditions and indicates the requirement for undercoats where applicable.

A new series of polyvinyl chloride (PVC) stabilizers, polymeric dialkyltin cycloaliphatic dimercaptides, has been developed that is reported to produce rigid

---

[3] Engineering and Mining Journal. Process Extracts Tin From Low-Grade Complex Ores. V. 173, No. 1, January 1972, p. 30.

[4] Tin International. German Volatilisation Process. V. 45, No. 9, September 1972, p. 275.

[5] Metal Bulletin. On-stream Analysis at Geevor. No. 5694, Apr. 25, 1972, p. 13.

[6] American Metal Market. Tin Oxide Developed for Plastics. V. 79, No. 83, Apr. 28, 1972, p. 11.

[7] American Metal Market. M & T Develops Acid Tin Plating Process. V. 79, No. 193, Oct. 20, 1972, p. 11.

[8] Quarterly Review Tin Research Institute. Tin and Its Uses. Developments in Tin-Lead Plating. No. 92, 1972, pp. 8–11.

[9] Quarterly Review Tin Research Institute. Tin and Its Uses. Tin as an Alloying Addition in Ferrous Materials. No. 94, 1972, pp. 9–10.

[10] Powder Metallurgy. Influence of Tin Powder Characteristics on the Sintering of Iron-Tin-Copper Powder Compacts. V. 15, No. 30, 1972, pp. 153–165.

[11] Quarterly Review Tin Research Institute. Tin and Its Uses. Tin in Cast Iron: B.C.I.R.A. Broadsheet, No. 92, 1972, p. 15.

[12] Quarterly Review Tin Research Institute. Tin and Its Uses. A New Standard for Tin-Nickel. No. 94, 1972, p. 7.

PVC with improved clarity that is easier to process.[13]

A catalytic system using dehydrated granular gels of tin (IV) oxide co-precipitated with vanadate was found effective in catalyzing the oxidation of carbon monoxide.[14] This process could be of importance in treating automobile exhaust gases to render them nontoxic.

Organotins, especially the trialkyltins, have shown increasing applicability in slow release pesticides.[15] With further research these pesticides may become competitive with or more effective than organophosphorus and halogenated hydrocarbon insecticides.

---

[13] Chemical Week. Technology Newsletter. V. 111, No. 4, July 26, 1972, p. 59.

[14] Quarterly Review Tin Research Institute. Tin and Its Uses. Tin Chemicals. No. 93, 1972, pp. 9–10.

[15] Quarterly Review Tin Research Institute. Tin and Its Uses. Pesticides Utilising Organotins. No. 93, 1972, pp. 16–18.

Titanium

By F. W. Wessel [1]

In 1972 production of rutile in the United States was reported for the first time in several years. Titanium Enterprises, Clay County, Fla., began in midsummer to produce rutile and other heavy-sand minerals. Rutile imports, almost entirely from Australia, were 9% less than in 1971. Imports of ilmenite were 35% lower, but imports of Sorel slag were 13% higher. A plant to produce 185,000 tons per year of ilmenite concentrate was under construction in New Jersey, and was expected to come onstream early in 1973. For the first time "synthetic" rutile made from ilmenite became a market factor; imports were from Australia and Japan.

Strong demand for titania pigment continued unchecked throughout the year. The demand was based on several factors, foremost of which were an active building construction and housing market and the necessity of replacing at least part of the void left by cessation of composite pigment production. Production of titania pigment increased only slightly, and imports were obtained to meet the demand. West Germany, Canada, Japan, France, Finland, and the United Kingdom were the major sources. There were some domestic price increases about midyear, but price controls and previously concluded contracts were inhibiting factors. Two major European producers also increased prices during the year, reflecting spreading shortages.

The general titanium metal situation showed slight gains over 1971. Production of titanium sponge was resumed in February and increased steadily through August, when it reached its yearend level at about one-third of industry capacity. Recovery was assisted in some measure by Federal stockpile contracts, concluded in June with two major producers. Production of ingot increased 10%, and mill products shipments increased 12%. Consumption of sponge, scrap, and ingot showed increases of 8%, 27% and 14%, respectively. Early in the year fabricators increased mill product prices by 8%.

Legislation and Government Programs.—The stockpile objectives for rutile and titan-

[1] Physical scientist, Division of Nonferrous Metals.

Table 1.—Salient titanium statistics

	1968	1969	1970	1971	1972
United States:					
Ilmenite concentrate:					
Mine shipments___short tons__	960,118	893,034	920,964	713,610	[1] 729,428
Value____________thousands__	$19,484	$18,636	$18,626	$15,936	$16,774
Imports [2]_________short tons__	178,154	110,853	231,119	185,618	183,846
Consumption__________do____	959,558	1,003,501	972,314	898,783	786,384
Titanium slag: Consumption_do____	142,168	138,553	129,247	143,554	264,095
Rutile concentrate: [3]					
Imports________________do____	174,366	204,645	243,089	215,109	195,068
Consumption__________do____	160,273	185,432	189,172	225,498	242,758
Sponge metal:					
Imports for consumption do____	3,349	5,745	5,931	2,802	4,078
Consumption__________do____	14,237	20,124	16,414	12,145	13,068
Price: Dec. 31, per pound [4]____	$1.32	$1.32	$1.32	$1.32	$1.32
World production:					
Ilmenite concentrate short tons__	3,222,247	r 3,532,151	3,962,540	3,705,134	3,586,377
Rutile concentrate__________do____	332,792	r 436,821	459,507	423,815	356,853

r Revised.
[1] Includes a small quantity of rutile.
[2] Includes titaniferous slag.
[3] Mine shipments withheld to avoid disclosing individual company confidential data.
[4] Nominal. Actual sales probably in $1.10–$1.20 range.

ium sponge metal remained at 100,000 tons and 33,500 tons, respectively. Government inventory of rutile at yearend was 56,525 tons. Total stockpile inventories of sponge metal at yearend were 35,015 tons, of which 8,514 tons are of substandard grade and available for disposal.

The General Services Administration (GSA) about midyear concluded identical contracts with Titanium Metals Corporation of America and RMI Co. for 6,500 tons of titanium sponge, to bring stockpiled material up to the 33,500 ton objective. Each firm will deliver 3,250 tons over a 2-year period, and will be reimbursed entirely in the form of various materials excess to the stockpile and authorized for disposal.

Government exploration assistance for rutile, available through the Office of Minerals Exploration, U.S. Geological Survey, remained at 75% of the approved cost of exploration. The depletion allowance for ilmenite and rutile remained at 22% for domestic deposits and 14% for foreign deposits.

DOMESTIC PRODUCTION

Concentrates.—Production of titanium-mineral concentrates in 1972 remained essentially unchanged from the 1971 level, while shipments increased 2.2% in gross weight and 6.0% in titanium content. The average grade of concentrates shipped has been increasing for several years, and now stands at 56.5% TiO_2. Producers were E. I. du Pont de Nemours & Co., Starke and Highland, Fla.; Titanium Enterprises, Green Cove Springs, Fla.; Humphreys Mining Co., Folkston, Ga.; SCM Corporation, Glidden-Durkee Division, Lakehurst, N.J.; and NL Industries, Inc., Tahawus, N. Y.

Rutile was produced for the first time since 1968. Titanium Enterprises, jointly held by American Cyanamid Co. and Union Camp Corp., began operation in mid-1972, producing rutile, ilmenite, and zircon. Nominal capacity of the plant is 140,000 tons of heavy-sand concentrate annually.

In April the Dravo Corp. began construction of a $10 million facility to mine and process ilmenite-bearing sands in Manchester township, Ocean County, N. J. The plant will consist of a floating suction dredge and land-based wet and dry concentrators. American Smelting and Refining Co. owners of the property, expect the plant to come onstream during the second quarter of 1973. They have a 10-year contract to supply ilmenite to du Pont's chloride-process titanium pigment plants at the minimum rate of 125,000 tons per year.

In June, Titanium Minerals, Inc., announced its intention to mine rutile and ilmenite in Nelson County, Va. A pilot plant was to be built to prove out the amenability of the ores to processing.

Ferroalloys.—Production of ferrotitanium of all grades was under 1,000 tons, as steel companies increased their use of off-grade titanium metal. Producing companies were Shieldalloy Corp., Newfield, N.J., Union Carbide Co., Niagara Falls, N. Y., and Foote Mineral Co., Cambridge, Ohio. The alloys were made variously from scrap, slag, and mineral concentrates.

Metal.—Production of titanium sponge was 1% higher than in 1971. Producing companies were Titanium Metals Corporation 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 U.S. Steel Corp. A third former producer, Oregon Metallurgical Corp., while still producing ingot, did not reactivate its sponge plant.

TMCA resumed sponge production in February and RMI Co. in April. Production increased steadily throughout the year; of the total 1972 output, 72% was produced during the second half. Deducting the quantity delivered to the stockpile, second half production was still more than double that of the first half.

Production of titanium ingot was 20,267 tons, an increase of 10% over the 1971 level. As in 1971, nine companies produced ingot; these were:

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 Corporation of America.	Henderson, Nev.
Titanium West, Inc	Reno, Nev.
TiTech International, Inc	Pomona, Calif.

Pigment.—Heavy demand for both rutile and anatase grades of titania pigment became evident in February and continued unabated throughout the year. Production consequently increased 1.5% over 1971 volume, and shipments about 10%. Rutile-type pigment amounted to 70% of total production, and was produced by all seven manufacturers. Anatase-type pigment was made by five companies. NL Industries closed their composite pigment plant in St. Louis early in the year, ending domestic production of this material. At the yearend, companies producing titania pigment, and their plant locations, were as follows: American Cyanamid Co., Savannah, Ga.; Kerr-McGee Chemical Corp., Hamilton, Miss.; E. I. du Pont de Nemours & Co., Antioch, Calif., Edge Moor, Del., and New Johnsonville, Tenn.; NL Industries, Inc., Sayreville, N. J., and St. Louis, Mo.; New Jersey Zinc Co. (a Gulf & Western Industries unit), Gloucester, N. J., and Ashtabula, Ohio; SCM Corporation, Glidden-Durkee Division, Baltimore, Md.; and Sherwin-Williams Chemical Co., Ashtabula, Ohio. The New Jersey Zinc Co. plant at Ashtabula was leased from Cabot Titania, Inc., late in May, with an option to buy.

During the period June 1, 1971, to January 31, 1972, four domestic titania pigment production plants were closed; total capacity lost amounted to 124,000 tons. New capacity coming onstream during 1972 was limited to du Pont's 30,000-ton expansion at New Johnsonville, where production began late in March. An additional 45,000 tons of capacity is to be installed at New Johnsonville, and will come onstream at intervals during 1973; the first 15,000 tons added production is expected in the second quarter. Plans for unspecified additional capacity at the Kerr-McGee plant were reported.

A 17-week strike at the St. Louis plant of NL Industries ended in July. However, loss of production was small because supervisory personnel operated the plant at about 80% of normal output.

Welding Rod Coating.—A total of 245,000 tons of welding rods containing titaniferous materials in their coatings was produced. Of the total output, 32% contained rutile, 46% contained ilmenite or leucoxene, 7% contained a mixture of rutile and manufactured titanium dioxide, 10% contained manufactured titanium dioxide alone, and 5% contained titanium slag and miscellaneous mixtures.

Table 2.—Production and mine shipments of titanium 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)
1968	978,509	960,118	506,260	$19,484
1969	931,247	893,034	480,918	18,636
1970	867,955	920,964	487,298	18,626
1971	r 683,075	r 713,610	r 388,802	r 15,936
1972	681,644	729,428	411,928	16,774

r Revised.
[1] Includes a mixed product containing rutile, leucoxene, and altered ilmenite.

Table 3.—Titanium metal data

(Short tons)

	1968	1969	1970	1971	1972
Sponge metal:					
Imports for consumption	r 3,349	r 5,745	r 5,931	r 2,802	r 4,078
Industry stocks	2,600	1,909	2,516	2,724	1,816
Government stocks (DPA inventories) [1]	20,711	20,385	19,994	19,994	19,994
Consumption	14,237	20,124	16,414	12,145	13,068
Scrap metal consumption	4,701	7,566	7,242	6,149	7,802
Ingot: [2]					
Production	19,234	28,490	24,331	18,387	20,267
Consumption	18,323	27,082	23,687	17,058	19,499
Net shipments of mill products [3]	11,900	15,940	14,480	11,241	12,627

r Revised.
[1] As of June 30 each year.
[2] Includes alloy constituents.
[3] Bureau of the Census and Business and Defense Services Administration, Current Industrial Reports Series BDCF-263. Net shipments are derived by subtracting the sum of producers' receipts of each mill shape from the industry's gross shipments of that shape.

Table 4.—Titanium pigment data

(TiO_2 content)

Year	Production (short tons)	Shipments [1]	
		Quantity (short tons)	Value, f.o.b. (thousands)
1968	623,691	632,106	$323,216
1969	664,253	654,490	334,521
1970	655,293	643,746	320,014
1971	r 677,751	684,698	311,140
1972	p 687,522	NA	NA

p Preliminary. r Revised. NA Not available.
[1] Includes interplant transfers.

Source: Bureau of the Census.

CONSUMPTION AND USES

Concentrates.—Consumption of ilmenite and Sorel slag was 12% lower and 84% higher, respectively, than in 1971. Both are used almost entirely to make titanium dioxide. Consumption of rutile increased 5% during the year.

Metal.—Consumption of sponge and ingot increased 7.6% and 14.3%, respectively; mill products shipments increased 12.3%, indicating a general, if modest, market improvement. A comparison of end uses [2] indicates the increased application of titanium in industry and commercial aircraft, in percent:

	1961	1971
Military and space uses	81	38
Commercial aircraft:		
Airframe	4	15
Engine	10	31
Industrial uses	5	16

Strikes during part of January at the mill products plant of TMCA at Toronto, Ohio, and during January and February at the mill products plant of RMI Co. at Niles, Ohio, resulted in a 20% reduction of shipments during those 2 months.

Titanium is being used in the gas turbine engines under construction for use in the U.S. Navy's Spruance-class destroyers. Each vessel will have four engines; each engine will contain at least 690 pounds of titanium. Nine vessels of an expected total fleet of 30 have been authorized. Titanium cathodes are being used increasingly as starting sheets in copper electrorefining.

Scrap consumption increased 27% in 1972. Some shortage appeared during the last 4 months as a result of decreased ingot

[2] Minkler, W. W. Application and Economics of Titanium 1972. 2d Internat. Conf. on Titanium, Cambridge, Mass., May 2–5, 1972, 14 pp.

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
1968	959,558	510,353	142,168	100,591	160,273	153,600
1969	1,003,501	541,840	138,553	98,075	185,432	178,090
1970	r 972,314	r 519,766	129,247	91,639	r 189,172	r 181,402
1971:						
Alloys and carbide	(2)	(2)	(3)	(3)	(2)	(2)
Pigments	r 888,208	r 479,316	r 143,554	r 101,751	r 189,377	r 181,535
Welding-rod coatings and fluxes	(2)	(2)	(3)	(3)	r 13,784	r 13,107
Miscellaneous [4]	r 10,575	r 6,955	--	--	r 22,337	r 21,274
Total	r 898,783	r 486,271	r 143,554	r 101,751	225,498	r 215,916
1972:						
Alloys and carbide	(2)	(2)	(3)	(3)	(2)	(2)
Pigments	775,618	453,248	264,095	187,608	208,704	199,894
Welding-rod coatings and fluxes	(2)	(2)	(3)	(3)	11,022	10,392
Miscellaneous [4]	10,766	8,174	--	--	23,032	21,945
Total	786,384	461,422	264,095	187,608	242,758	232,231

e Estimated. r Revised.
[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, glass fibers, and titanium metal.

Table 6.—Distribution of titanium-pigment shipments, by industry

(Percent)

Industry	1968	1969	1970	1971 r	1972
Distribution by gross weight:					
Paints, varnishes, and lacquers	60.7	58.5	59.6	57.7	53.0
Paper	14.9	17.0	17.0	17.8	20.4
Floor coverings	2.4	2.3	1.8	2.1	2.1
Rubber	2.9	2.6	2.6	2.7	3.6
Coated fabrics and textiles (oil cloth, shade cloth, artificial leather, etc.)	1.4	1.3	1.3	1.0	1.5
Printing ink	2.1	2.3	2.2	2.1	2.1
Roofing granules	.8	.9	.9	1.0	.3
Ceramics	2.1	2.0	1.8	2.0	2.3
Plastics (except floor covering and vinyl-coated fabrics and textiles)	6.0	6.2	6.6	6.5	7.7
Other (including export)	6.7	6.9	6.2	7.1	7.0
Total	100.0	100.0	100.0	100.0	100.0
Distribution by titanium dioxide content:					
Paints, varnishes, and lacquers	56.5	54.3	55.8	54.4	52.0
Paper	17.4	19.5	19.3	19.7	20.9
Floor coverings	2.7	2.6	2.1	2.4	2.1
Rubber	3.3	3.0	3.0	3.0	3.7
Coated fabrics and textiles (oil cloth, shade cloth, artificial leather, etc.)	1.6	1.4	1.4	1.1	1.5
Printing ink	2.4	2.6	2.5	2.3	2.2
Roofing granules	1.0	1.1	1.0	1.1	.3
Ceramics	2.4	2.4	2.1	2.2	2.4
Plastics (except floor covering and vinyl-coated fabrics and textiles)	6.9	7.1	7.6	7.1	7.9
Other (including export)	5.8	6.0	5.2	6.7	7.0
Total	100.0	100.0	100.0	100.0	100.0

r Revised.

production between September 1971 and February 1972.

Pigments.—Although production increased only about 1.5%, shipments increased 8% to 10% over 1971 levels, based on preliminary figures. The excess of shipments over production represents delivery of imported material and withdrawal from producers' inventories. The manufacture of paper, rubber, and plastics each accounted for a somewhat increased proportion of the total consumed.

STOCKS

In 1972, stocks of rutile in the United States declined 34% to 157,425 short tons. Ilmenite inventories were 20% less than in 1971, but stocks of titanium slag, at 157,731 tons, were 46% higher. Yearend stocks of titanium sponge were 1,816 tons, one-third less than at yearend 1971, and scrap inventories stood at 4,375 tons, a 9% decrease. Industry stocks of titanium dioxide were estimated at yearend to be 48,250 tons, a decrease of 38,600 tons during the year.

Table 7.—Stocks of titanium concentrates in the United States, December 31

(Short tons)

	Gross weight	TiO_2 content e
Ilmenite:		
1970	r 808,522	r 458,046
1971	r 645,107	r 383,113
1972	518,973	300,633
Titanium slag:		
1970	115,256	81,761
1971	r 108,265	r 76,741
1972	157,731	114,940
Rutile:		
1970	r 237,555	r 227,689
1971	r 236,955	r 225,925
1972	157,425	150,150

e Estimate. r Revised.

PRICES

Concentrates.—No price quotations for domestic (60% TiO_2) ilmenite were available during 1972; any such figure would be nominal since mines are captive and no ilmenite is sold on the open market. Imported material of 54% content was quoted by Metals Week throughout the year at $22–24 per long ton, bulk, at Atlantic coast ports; the same concentrate brought A$10.50–A$11.50 f.o.b. Australian ports. Indian ilmenite (58 to 60%) was quoted at the equivalent of US$9.75 f.o.b. Indian west coast ports. Malayan ilmenite (52% to 54%) was quoted at yearend in the range of £9.35 to £11.32 per metric ton c.i.f. British ports.

Rutile, bulk, f.o.b. cars at Atlantic and Great Lakes ports ended 1971 at $185 per short ton but fell to $175 early in 1972; this price was maintained throughout the yearend. Australian prices for rutile were weak during much of the year, falling from A$145–A$155 in mid-1971 to A$110–A$120 in April 1972, and rising to A$115–A$125 later in the year.

Titanium slag (70%–71% TiO_2) held to the price of $50 per long ton, f.o.b. Quebec, throughout the year.

Manufactured Titanium Dioxide.—In view of continued strong demand, considerable upward price pressure developed during the year. About midyear, Kerr-McGee Chemical Corp. raised its price for rutile-type pigment 2 cents per pound, and the Glidden-Durkee division of SCM Corp. raised both rutile and anatase grades 1 cent. American Cyanamid Co. raised its price for rutile and wet-milled anatase 1 cent per pound, effective August 1; NL Industries announced a similar increase at about this time. Accordingly, in August a three-level price structure existed, at least for the rutile grades: Kerr-McGee at 28 cents, American Cyanamid, NL Industries, and SCM at 27 cents, and du Pont, unchanged, at 26 cents. Effective December 11, du Pont raised its price for paper-grade anatase 1 cent per pound, and New Jersey Zinc Co. announced a similar increase effective Jan. 1, 1973. The increases were reflected abroad; British Titan Products, Ltd., and its French affiliate, Tioxide, and the NL subsidiary Kronos, in Belgium, each announced a 7% rise in price.

Closing 1972 prices, reflected in the Chemical Marketing Reporter for Apr. 16, 1973, were as follows:

	Price, cents per pound
Anatase:	
20-ton lots, bags, freight allowed	27–28½
20-ton lots, bags, paper grade	23–24
Slurry, 50 tons (dry TiO_2 basis) in railcars, f.o.b. plant	22½–23½
Rutile:	
Regular grades, 20-ton lots, bags, freight allowed	26–28½
Nonchalking grade, 20-ton lots, bags, freight allowed	27–29½
Bulk, 65-ton lots, in railcars, f.o.b. plant, 1 cent per pound less than above quotes.	

Metal.—Sponge imported from Japan and the United Kingdom was quoted in the range of $1.20–$1.25 per pound throughout the year. Domestic sponge continued to be quoted at $1.32; however, it is believed that most sales during 1972 took place in the $1.10–$1.20 range.

FOREIGN TRADE

Titanium dioxide exports in 1972 amounted to 10,335 short tons, 39% of the 1971 quantity, reflecting the strong domestic demand. Of the total, 31% went to Canada, 16% to the Republic of Korea, 16% to European nations, and 13% to Japan. Value of the titanium dioxide exported was $4.9 million. Exports of 3,510 tons of sponge, waste, and scrap, valued at $2.2 million, was about twice the 1971 figures; 40% went to the United Kingdom, 32% to Italy, and 15% to Belgium. Wrought titanium and semimanufactures exported totaled 1.1 million pounds valued at $6.3 million; principal destinations were Canada 46%, the United Kingdom 18%, other EEC nations 20%, and Japan 5%.

Imports of ilmenite from Australia dropped 35% to 14,334 short tons, valued at $142,200. Imports of Sorel slag from Canada, at 169,327 tons, increased 13% above 1971 receipts, and were valued at $7.5 million. Rutile was received from Australia in about the same quantity and value as in 1971. Imports of sponge, waste, and scrap titanium totaled 4,173 tons, mainly sponge from Japan (56%) and the U.S.S.R. (34%). The Japanese material was valued at $4.25 million, or 91 cents per pound, and the Soviet sponge at $2.1 million, or 75 cents per pound. France and the United Kingdom were the principal sources of 181,326 pounds of ferrotitanium of various grades, valued at $75,561.

Heavy imports of titanium dioxide featured 1972; the total was 86,379 tons valued at $33.4 million. Major suppliers were West Germany (28%), Canada (20%), Japan (13.5%), France (12%), the United Kingdom (9.5%), and Finland (9%). Imports accounted for 10.7% of domestic demand, and were about double the 1971 receipts.

Imports of synthetic rutile (beneficiated ilmenite) were of interest in 1972; a total of 9,200 tons of experimental product entered the country, 8,750 tons from Australia and the balance from Japan. Valuations were at $90 and $60 per ton for Australia and Japan, respectively.

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	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1970	1,058	$201	2,902	$2,588	1,740	$10,435	26,194	$7,950
1971	1,760	299	1,711	1,139	430	4,788	26,759	9,378
1972	1,802	394	3,510	2,165	562	6,265	10,335	4,882

Table 9.—U.S. imports for consumption of titanium concentrates, by country

Country	1970		1971		1972	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
Ilmenite:						
Australia	96,123	$976	21,953	$218	14,334	$142
Canada [1]	134,996	5,455	150,188	6,465	169,327	7,504
Finland	--	--	302	18	--	--
India	--	--	13,175	1,118	--	--
Malaysia	--	--	--	--	185	2
Total	231,119	6,431	185,618	7,819	183,846	7,648
Rutile:						
Australia	223,407	18,395	196,555	21,664	195,029	21,728
Austria	--	--	--	--	22	3
Denmark	--	--	--	--	17	2
Japan	--	--	500	19	--	--
Sierra Leone	19,682	1,401	18,054	1,472	--	--
Total	243,089	19,796	215,109	23,155	195,068	21,733

[1] Mainly titanium slag averaging about 70% TiO_2. Data does not include ilmenite ore for use as heavy aggregate imported in quantities of 30,744 short tons in 1970, 192,431 short tons in 1971, 211,372 short tons in 1972.

Table 10.—U.S. imports for consumption of unwrought titanium and waste and scrap

Country	1970		1971		1972	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
Austria	--	--	4	$3	--	--
Belgium-Luxembourg	13	$30	--	--	--	--
Canada	111	96	118	128	12	$9
France	3	4	--	--	10	10
Germany, West	142	153	r 41	r 28	141	147
Italy	--	--	(1)	1	(1)	1
Japan	4,507	7,436	r 2,523	r 4,375	2,345	4,255
Netherlands	9	6	3	3	2	2
South Africa, Republic of	--	--	--	--	2	1
Sweden	25	26	--	--	--	--
Switzerland	3	7	--	--	--	--
U.S.S.R.	1,035	1,662	214	331	1,408	2,109
United Kingdom	695	1,083	120	131	253	420
Total	6,543	10,503	3,023	5,000	4,173	6,954

r Revised.
[1] Less than ½ unit.

WORLD REVIEW

Australia.—The market for titanium minerals, particularly rutile, was rather weak throughout the year, with a firming trend noticeable near yearend. Moderate demand for concentrates and revaluation of both Australian and U.S. currencies combined to make 1972 a year of lower profits and two actual failures. Mines also complained of excessive responsibility for sand stabilization.

Litigation concerning the Eneabba claims continued during the year. In any case, it seemed clear that Allied Minerals N.L. would control enough of the deposit to proceed with development. About midyear, the 55% interest that had ben held by A. V. Jennings Industries (Australia) Ltd. was relinquished; Allied Minerals, backed by Westralian Oil N.L., sought a new partner, which shortly was announced as du Pont (Australia) Ltd. Du Pont's initial investment was A$1.75 million, plus the cost of a pilot-plant operation, in return for a 25% interest in the joint venture.

The plant of Coastal Rutile, Ltd., of Queensland, was purchased by Allied Minerals from the receiver for A$114,000, moved to Eneabba, and reerected. Its capacity there will be 7,000 tons of rutile and 28,000 tons of ilmenite annually. If successful, six additional units of similar capacity will be erected. No metallurgical difficulties are foreseen, with one possible exception: The heavy minerals are coated with a siliceous clay.

At yearend the new venture was christened Allied Eneabba Pty., Ltd. E. I. du Pont de Nemours & Co. contracted for delivery of 200,000 tons of ilmenite per year to its chloride-process pigment plants.

In addition to Coastal Rutile, Ltd., Naracoopa Rutile, Ltd., was also placed in receivership, and its rutile-zircon operations on King Island, Tasmania, sold to Buka Minerals, Ltd. The new management expects to begin operations early in 1973 at 10,000 tons of rutile and 5,000 tons of zircon per year. Operations were also suspended at the Matthew Flinders rutile-zircon operation near Yamba, New South Wales, by the Dillingham Mining Co.

A joint venture of Mining Corp. of Australia and Kamilaroi Mines, Ltd., is drilling sands at Jurien Bay, near Eneabba, to delineate a rutile-zircon-ilmenite body. Late in the year it was announced that enough reserves had been measured to support annual production of up to 25,000 tons of rutile, 30,000 tons of zircon, and 130,000 tons of ilmenite.

Cudgen R. Z. and its subsidiary, Consolidated Rutile, are considering integration of operations and of financial arrangements. Such a merger would make the resulting company Australia's third largest producer of rutile and zircon.

Interest in processes to convert ilmenite to rutile remained high. Western Titanium N.L. reportedly was proceeding with construction of a A$5.75 million plant at Bunbury, Western Australia, which will have initial capacity of 30,000 tons per year. Target date for full operation is late 1974 or early 1975. Expansion to 100,000-tons-per-year capacity is contemplated. Western Titanium continued shipping products from its pilot plant during the year.

Belgium.—The 22,000-ton-per-year titanium dioxide plant of Bayer N.V., subsidiary of Farbenfabriken Bayer A.G., at Antwerp resumed production in March; an explosion in a tumbler had interrupted operations.

Brazil.—The carbonatite formation at Tapira, Minas Gerais, long known to contain columbium minerals and phosphate, has recently been surveyed as a titanium source by the National Department of Mineral Production (DNPM). Reserves are reported at 1.6 billion tons of ore at 10% TiO_2 or more. Much of the titanium content appears to be in the less common mineral anatase, which may be concentrated to a purity approaching that of rutile. The undesirable colorizers chromium and vanadium are absent.

Canada.—Canadian Tiron Chemical Corp. is developing a pilot plant in the Montreal area that will be directed toward making rutile from ilmenite. The process was not described, but it is said to use hydrogen as a reductant.

France.—Thann et Mulhouse, a major European producer of titania pigments, having shelved plans early in the year for expansion of its sulfate-process plant at LeHavre, was restudying the matter in September. Present capacity at LeHavre is 91,500 short tons per year. At Calais, Tioxide, associated with British Titan Ltd., completed its expansion to 66,000 tons per year, also by the sulfate process.

Table 11.—Titanium: World production of concentrates (ilmenite and rutile), by country

(Short tons)

Country [1]	1970	1971	1972 p
Ilmenite:			
Australia	r 2 988,820	2 914,116	781,324
Brazil [3]	22,756	10,906	3,849
Canada (titanium slag) [4]	844,700	853,000	920,400
Finland	166,449	153,772	e 150,000
India e	r 86,000	73,000	76,000
Japan:			
Ilmenite concentrate	3,467	2,619	2,331
Titanium slag	8,683	6,097	3,668
Malaysia	212,145	171,941	5 167,743
Norway	638,193	707,198	670,723
Portugal	262	981	e 1,000
Spain	29,901	26,033	25,295
Sri Lanka	93,209	102,396	e 102,400
United States [6]	867,955	683,075	681,644
Total	r 3,962,540	3,705,134	3,586,377
Rutile:			
Australia	405,156	404,233	349,899
Brazil	258	129	454
India e	r 2,400	3,200	3,400
Sierra Leone	48,593	13,153	--
Sri Lanka e	3,100	3,100	3,100
Total	r 459,507	423,815	356,853

e Estimate. p Preliminary. r Revised.

[1] In addition to the countries listed, the U.S.S.R. also produces titanium concentrates, but available information is inadequate to make reliable estimates of output levels.

[2] Includes leucoxene.

[3] Production of Comissão Nacional de Energia Nuclear only.

[4] Containing 70–72% TiO_2.

[5] Exports.

[6] Includes a mixed product containing ilmenite, leucoxene, and rutile.

Italy.—Montecatini-Edison, S.p.A., was reported planning to build a facility at Priolo, Sicily, to produce titanium dioxide, titanium sponge, and silica. The company's titanium dioxide plant at Scarlino, its opening delayed since December 1971 pending satisfactory waste disposal arrangements, finally began operations in May. The sulfate wastes were barged to deep water. Late in the year, Società Italiana Resina resumed construction of a 22,000-ton sulfate-process plant to make TiO_2 at Porto Torres, Sardinia. Production is expected by yearend 1973.

Japan.—Production of titanium sponge declined to 5,133 short tons from the 1971 level of 7,470 short tons, a 31% decrease. However, quarterly figures showed a steady increase, and fourth-quarter production was at a 5,800-ton annual rate. Exports of sponge were estimated at a little over 2,000 tons. Titanium slag production decreased to 3,668 tons; after a virtually inactive third quarter, production resumed at an annual rate of 3,250 tons. Ishihara Sangyo Kaisha Ltd., having for 18 months successfully converted ilmenite to rutile, is considering 50% expansion of its plant, bringing it to 45,000-ton capacity. The company is also considering building another pigment plant. Mitsubishi Chemical Corp. is testing another ilmenite-to-rutile process, based on partial chlorination to remove iron, and may erect a 10,000-ton pilot plant on Australia's east coast to process the local off-grade ilmenite.

Norway.—Production of ilmenite concentrates in 1972 was 671,000 tons, a decrease of 5% from 1971 volume.

Sierra Leone.—The Government of Sierra Leone on February 4 entered into an agreement with Sierra Rutile, Ltd., a company owned 60% by Armco Steel Corp. and 40% by Nord Resources Corp. The agreement grants Sierra Rutile exclusive prospecting rights for titanium in the area lately relinquished by Sherbro Minerals, Ltd., and is convertible to a mining lease at the company's request.

South Africa, Republic of.—The Government-owned Industrial Development Corp. announced plans for heavy-sand mining at a large deposit at Richards Bay, Natal. Financial and political difficulties, however, may defer action.

Sri Lanka.—The Asian Development Bank at the close of 1971 approved a $4.15 million loan to Ceylon Mineral Sands Corp., a government-owned company, for expanding and rationalizing its black-sand facilities at Pulmoddai on the northeast coast. Present facilities include mining equipment and a magnetic separation plant at Pulmoddai, where an ilmenite concentrate is made; tailings from this operation are then barged to China Bay, 14 miles down the coast, for recovery of rutile and zircon. Recent fiscal year production has been of the order of 90,000–95,000 tons of ilmenite and 2,100–2,700 tons of rutile; zircon capacity is not yet fully effective. The expansion, with an expected completion date in 1975, will increase annual capacity to 140,000 tons of ilmenite, 12,000 tons of rutile, 8,000 tons of zircon, and a little monazite. The China Bay plant will be moved to Pulmoddai. Feasibility studies of smelting the ilmenite to make titania slag and pig iron are underway.

Taiwan.—The Taiwan Alkali Corp. Ltd., a subsidiary of China Petroleum Corp., announced in July that a plant to produce synthetic rutile from ilmenite was under construction, and that production was expected during the third quarter of 1973. Taiwan Alkali is licensed to use the Benilite process.

Thailand.—Several plants have begun operation during the year to recover byproduct minerals from tin concentration tailings. Ilmenite of pigment grade is among the products, one company reporting an analysis of 53.55% TiO_2, 38.08% FeO, and low chromium.

United Kingdom.—Laporte Industries (Holdings) Ltd. has reported some progress toward effective operation of its 40,000-ton chloride-process titanium dioxide plant at Stallingborough, Lancashire. Full production is reported from the company's two sulfate-process plants, one at Stallingborough, the other at Bunbury, Western Australia.

British Titan, Ltd. (BTP), reported production in excess of nominal capacity at their new 30,000-ton chloride-process titania plant at Greatham. Late in the year, Rio Tinto-Zinc Corp., one of four owners of BTP, reported sale of its 30% interest to the other three partners.

U.S.S.R.—Estimated production of titanium sponge in 1972 was 13,500 short tons, a small increase over 1971 output.

TECHNOLOGY

A materials survey covering geology, mineralogy, extractive metallurgy, and a review of various methods to convert ilmenite to a high-titania product was published.[3] A somewhat similar paper presented in greater detail (1) currently available information on occurrence, reserves, and production of, and demand for, titanium minerals; (2) a discussion of the alteration of ilmenite in nature, and (3) a discussion of the application of thermal reduction, selective chlorination, and selective leaching to the ilmenite-rutile conversion.[4]

A process was described in which iron is smelted out of ilmenite under a sodium borate slag. An acid-soluble but water-insoluble sodium titanate is formed, from which the TiO_2 can be extracted with minimum pollution; the borate is recycled.[5] The Bureau of Mines also was investigating an alternate method of making a high-grade TiO_2 product from ilmenite, in which the concentrate is chlorinated. The iron is separated as a chloride, from which the chlorine is liberated for reuse.[6]

Both rutile and anatase types of pigment have been made available by producers as slurries. A small quantity of a dispersant is added, and 70 tons of pigment in a water suspension is pumped into a 100-ton tank car. One-half hour of air agitation before unloading is sufficient to stir up settled material. Unloading the car takes 45 minutes, storage of the slurry requires less floor space than dry material, and subsequent handling in the plant is far more flexible.

Early in the year Mallinckrodt Chemical Co. took delivery of a 2,700-gallon titanium tank truck, intended for hauling corrosive chemicals.[7] Its advantages over rubber-lined tanks are that (1) it may be used for several different chemicals in sequence with minimum washing between loads, (2) it

[3] Pings, W. B. Titanium. Miner. Ind. Bull., v. 15, No. 4, July 1972, 13 pp.
[4] Mackey, T. S. Alteration and Recovery of Ilmenite and Rutile. Australian Min., v. 64, No. 11, November 1972, pp. 18–44.
[5] U.S. Bureau of Mines. Borate Smelting of Ilmenite. Bureau of Mines Research 1972, 1973, p. 29.
[6] U.S. Bureau of Mines. Chlorination of Ilmenite. Bureau of Mines Research 1972, 1973, p. 29–30.
[7] American Metal Market. Titanium Tank Truck Proves Money Saver. V. 79, No. 44, Mar. 6, 1972, p. 15.

does not deteriorate nor contaminate the contents, and (3) because of its lighter weight, it can carry 8% more material per unit of dead load.

In June the U.S. Supreme Court refused to review a circuit court decision invalidating the Westinghouse Electric Corp. patent for double-melting of refractory metals.[8] The patent[9] had been successfully challenged by Titanium Metals Corporation of America.

The effect of titanium in blast furnace slags has been reevaluated.[10] Research has determined the ability of the ironmaking process to tolerate titanium oxides up to 10%, and actually to act as a flux up to that point. Unless other adverse conditions arise, these data would seem to point to (1) use of titaniferous magnetites as blast furnace feed, and (2) possible use of Sorel slag as a substitute for fluorspar.

[8] Metals Week. Titanium Melting Patent Invalidated. V. 43, No. 25, June 19, 1972, p. 7.
[9] Gordon, R. B., and W. J. Hurford (assigned to Westinghouse Electric Corp.). Method of Producing Sound and Homogeneous Ingot. U.S. Pat. 3,072,982, Jan. 15, 1963.
[10] Handfield, G., G. G. Charette, and H. Y. Lee. Titanium Bearing Ore and Blast Furnace Slag Viscosity. J. Metals, v. 24, No. 9, September 1972, pp. 37–40.

Tungsten

By Richard F. Stevens, Jr.[1]

The domestic tungsten industry recovered significantly in 1972 as production of tungsten concentrate increased 18% to 8.2 million pounds, and concentrate consumption rose 21% to 14.1 million pounds. Imports for consumption of tungsten concentrate rose to a 14 year high and totaled 5.7 million pounds. Concentrate exports in 1972 decreased sharply and totaled slightly less than 0.1 million pounds.

During 1972, the reported price of shipped tungsten concentrate, f.o.b. domestic mines, averaged almost $41 per short ton unit; the quoted European price averaged almost $36 per short ton unit (about $40 per short ton unit with U.S. duty added).

The Government's two-phase tungsten disposal program was continued unchanged during the year at $55 per short ton unit, but only one minor sale was made. Releases which, in previous years, balanced U.S. supply and demand were replaced by less expensive imports.

The low level of European prices reflected the continued decline in foreign industrial activity. Primarily as a result of low tungsten prices, one major European metal trader was forced to declare bankruptcy.

A detailed statistical record of tungsten production, consumption, and trade, by country, was reported quarterly by the United Nations.[2]

Legislation and Government Programs.—Although the General Services Administration (GSA) continued its stockpile disposal programs during the year, only 3,457 pounds of tungsten, in subspecification material, was sold. Under PMDS-ORES-124, excess tungsten concentrate was offered for

[1] Physical scientist, Division of Ferrous Metals.
[2] UNCTAD Committee on Tungsten (Geneva, Switzerland). Tungsten Statistics. V. 6, Nos. 1–4, January, April, July and October 1972; V. 7, Nos. 1–2, January and April 1973.

Table 1.—Salient tungsten statistics

(Thousand pounds of contained tungsten and thousand dollars)

	1968	1969	1970	1971	1972
United States:					
Concentrate:					
Production	8,663	7,805	9,625	6,900	8,150
Shipments	9,042	7,910	9,312	6,827	7,045
Value	$20,293	$18,770	$23,790	$20,184	$18,104
Consumption	11,038	13,053	16,700	11,622	14,107
Releases from Government stocks	3,225	38,314	15,066	1,381	3
Exports [1]	623	7,151	19,470	2,006	95
Imports, general	1,824	1,534	1,299	577	5,898
Imports for consumption	1,743	1,503	1,284	418	5,739
Stocks, Dec. 31:					
Producers	626	519	787	863	1,966
Consumers	574	1,066	1,467	2,657	2,229
Primary products:					
Production	10,538	13,334	17,605	11,730	14,090
Consumption	13,108	16,056	15,352	11,159	13,296
Stocks, Dec. 31:					
Producers	4,747	3,392	4,569	3,722	4,680
Consumers	2,364	1,778	2,698	2,541	2,121
World: Ore and concentrate:					
Production	68,380	71,754	71,360	80,744	84,793
Consumption	64,410	76,650	85,638	68,382	76,197

[1] Estimated tungsten content.

sale, for domestic consumption only, at a "shelf" price of $55 per short ton unit adjusted for premiums and penalties. Excess tungsten concentrate, for export, was offered for sale on a monthly sealed-bid basis under PMDS-ORES-123. No concentrate was sold during the year under this program.

H.R. 1257, a bill to temporarily suspend the import duty on tungsten concentrate and on other materials in chief value of tungsten, primarily synthetic scheelite, was introduced before the 93rd Congress on January 3, 1973, and referred to the Committee on Ways and Means.

The first report by the Secretary of the Interior made under the Mining and Minerals Policy Act of 1970 (Public Law 91-631) was released during the year and evaluated the domestic tungsten market.[3] The independent National Commission on Materials Policy, which was formed by Public Law 91-512 on October 26, 1970, to update the 1952 report of the President's Materials Policy Commission, the Paley Commission, and review the Government's policy on materials, issued two interim reports.[4] The Commission's final report, with its findings and recommendations, will be submitted to the President and to the Congress no later than June 30, 1973.

3 Department of the Interior. First Annual Report of the Secretary of the Interior Under the Mining and Minerals Policy Act of 1970 (Public Law 91-631). March 1972, 142 pp.
———. First Annual Report of the Secretary of the Interior Under the Mining and Minerals Policy Act of 1970 (Public Law 91-631)—Appendices. March 1972, 436 pp.

4 National Commission on Materials Policy. Toward a National Materials Policy—World Perspective. January 1973, 87 pp.
———. Towards a National Materials Policy—Basic Data and Issues. April 1972, 64 pp.

Table 2.—U.S. Government tungsten stockpile materials inventories and objectives

(Thousand pounds, tungsten content)

Material	Objective	Inventory by program Dec. 31, 1972: National (strategic) stockpile	DPA inventory	Supplemental stockpile	Total
Tungsten ore and concentrate:[1]					
Stockpile grade	55,656	[2] 75,890	5,164	[3] 3,478	84,532
Nonstockpile grade	--	36,947	566	978	38,491
Total inventory	--	112,837	5,730	4,456	123,023
Ferrotungsten	--	2,141	--	--	2,141
Tungsten metal powder, hydrogen reduced:					
Stockpile grade	1,200	[4] 1,276	--	--	1,276
Nonstockpile grade	--	22	--	--	22
Total inventory	--	1,298	--	--	1,298
Tungsten metal powder, carbon reduced:					
Stockpile grade	547	546	--	--	546
Nonstockpile grade	--	171	--	--	171
Total inventory	--	717	--	--	717
Tungsten carbide powder:					
Stockpile grade	1,900	841	--	1,080	1,921
Nonstockpile grade	--	112	--	--	112
Total inventory	--	953	--	1,080	2,033

1 Includes 760,812 pounds of tungsten concentrate sold but unshipped.
2 Includes 3,304,606 pounds of nonstockpile grade material credited to the concentrate objective.
3 Includes 174,433 pounds of nonstockpile grade material credited to the concentrate objective.
4 Includes 79,931 pounds of nonstockpile grade hydrogen reduced metal powder credited to the subobjective.

DOMESTIC PRODUCTION

Although domestic mine production increased 18% to almost 8.2 million pounds of tungsten during the year, mine shipments increased only 3% and totaled 7.0 million pounds. Much tungsten concentrate was stockpiled as producers awaited the development of higher prices. Although 37 mines in nine Western States reported production and 36 mines reported concentrate shipments, only two mines operated continuously throughout the year: The Pine Creek mine and mill of the Mining and Metals Division, Union Carbide Corp., near Bishop, Calif.; and the Climax mine and mill of Climax Molybdenum Co., a division of American Metal Climax, Inc. (AMAX), at Climax, Colo. At Pine Creek, tungsten was the primary mineral value recovered along with minor amounts of molybdenum, copper, silver, gold, lead, and zinc. The average grade of scheelite ore recovered by Union Carbide during the year decreased to about 0.6% WO_3 although production increased 26% and shipments rose 11%. This material was processed on a "straight through" basis and produced ammonium paratungstate (APT), an intermediate processed form of tungsten suitable for ready conversion to high-purity hydrogen-reduced tungsten metal powder.

At Climax, the major mineral value recovered was molybdenum. Concentrates of tungsten, tin, pyrite, and monazite were recovered as byproducts and were entirely dependent upon the rate of molybdenum production. Tungsten concentrate production increased about 11%, although mine shipments were essentially unchanged in 1972. The underground operations and reserves at Climax will be expanded by almost 40% with the addition of surface mining operations that will be phased in gradually as demand warrants. Initial production from the expanded operations is planned for 1974. The byproduct recovery circuit at Climax is being modified to upgrade tungsten recovery operations.[5] A new Reichert Cone separator will operate as a specific gravity-size separator, replacing the older spiral units. A review and description, including flowsheets, of the processing facilities at Climax includes an evaluation of the byproducts plant.[6]

The Tungsten Queen mine and mill of Ranchers Exploration and Development Corp. near Townsville, N.C., remained closed and on standby status throughout 1972.[7] The huebnerite ore of the deposit reportedly has an average content of less than 0.5% WO_3 and ore reserves have been estimated at about 1 million tons.

During the year, Rawhide Mining Co. produced substantial amounts of tungsten concentrate near Rawhide, Nev. from scheelite ore, which averaged about 1% WO_3. All production was sold to Kennametal Inc.

Additional tungsten concentrate production and/or shipments were also reported from Pima County, Ariz.; Inyo, San Bernardino, Tulare, and Tuolumne Counties, Calif.; Boulder and Lake Counties, Colo.; Custer and Valley Counties, Idaho; Deer Lodge and Granite Counties, Montana; Churchill, Elko, Esmeralda, Mineral, Nye, Pershing, and White Pine Counties, Nev.; Baker County, Oreg.; Tooele County, Utah; and Stevens County, Wash.

Under a preliminary agreement, General Electric Co. (GE), will purchase the tungsten properties, mill, and refinery of Minerals Engineering Co. (ME), near Dillon, Mont. Under the agreement, GE will cancel nearly $2 million in notes and interest owed to it by ME, pay $125,000 in cash to the Denver-based firm, and provide royalty payments on future production of up to $1.4 million. The sale will eliminate all of ME's indebtedness to GE and will retire most of the company's remaining short- and long-term debts. Under the agreement, ME will receive a 5% royalty on all production in excess of 200,000 short ton units of WO_3 (almost 3.2 million pounds of contained tungsten) from the Dillon properties.

Although exploration programs conducted by ME since mid-1971 have increased the tungsten ore resources in Montana, a recently completed study indicated that substantial additional expenditures would be required to find and develop additional reserves (material commercially recoverable at current prices).

As part of its program to locate and develop additional tungsten ore reserves in Western States, ME acquired two new scheelite tungsten properties. One of these deposits is the Searchlight property in the Bald Mountain district, White Pine County, Nev. The second, in the Ophir mining district near Avron, Mont., has previously reported intermittent scheelite production from two small open pit mines.

ME took an option on a promising tungsten discovery north of Round Moun-

---

5 American Metal Climax, Inc. Tungsten News. January 1973, p. 1. Available from AMAX, 1270 Ave. of the Americas, New York.

6 Engineering and Mining Journal. Molybdenum—The Firm Base for AMAX Diversification. V. 173, No. 9, September 1972, pp. 104–112.

7 Ranchers Exploration and Development Corp. Annual Report 1972, 24 pp.

tain, Nev., in an area where no production or exploration had been previously conducted. Substantial sections of this scheelite mineralization averaged between 2% and 3% WO_3 and were apparently free of molybdenum, pyrite, or other contaminants. To make a more detailed evaluation, ME will build an access road and make bulldozer cuts to expose the mineralized zone for further sampling. Current data indicate that this property should be suitable for open pit mining operations.

Small quantities of high-grade scheelite ore were produced from the Star Dust claims on Dutch Mountain, near Gold Hill, Utah. The sorted high-grade ore was concentrated to more than 65% WO_3 and sold to Kennametal Inc. at Fallon, Nev. The Fraction Lode property in the same district near the Utah-Nevada border produced mill-grade ore that was concentrated in a gravity separation plant at Redding Spring, 15 miles south of Gold Hill. The WO_3 content of the crude ore was believed to average about 1.5%.

During the year, Transcon Corp. began development of a mine in Elko County, Nev. and recovered low-grade concentrate containing 29% WO_3 from scheelite ores having an average grade of about 0.55% WO_3. Transcon produced and shipped 1,000 short ton units (15,862 pounds of contained tungsten) to the account of Teledyne Wah Chang Huntsville, Huntsville, Ala. This material was upgraded to APT under a toll conversion contract before being further processed at Huntsville. When full-scale production is achieved in 1973, Transcon expects to be capable of producing at a rate of about 250 tons per day. Transcon also indicated plans to upgrade its mill facility in the future to produce concentrates containing 25% to 45% WO_3.

Table 3.—Tungsten concentrate shipped from mines in the United States

Year	Quantity			Reported value f.o.b. mines [1]		
	Short tons 60% WO_3 basis [2]	Short ton units WO_3 [3]	Tungsten content (thousand pounds)	Total (thousands)	Average per unit of WO_3	Average per pound of tungsten
1968	9,501	570,040	9,042	$20,293	$35.60	$2.24
1969	8,312	498,706	7,910	18,770	37.64	2.37
1970	9,785	587,088	9,312	23,790	40.52	2.55
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

[1] Values apply to finished concentrate and ore 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.

CONSUMPTION AND USES

Table 5 lists the major domestic companies that were engaged in tungsten processing during 1972 and that reported consumption of over 0.6 million pounds of tungsten annually.

The use of tungsten in cutting and wear-resistant materials, primarily as tungsten carbide, continued to represent the major end use form of tungsten consumption and accounted for 50% of total tungsten product consumption which rose 19% to 13.3 million pounds of tungsten in 1972. The other major end use categories were: Mill products (19%), specialty tool steels (11%), and welding and hardfacing materials (9%). The consumption of intermediate tungsten products used to make end use items during the year was: Tungsten carbide (including cemented, crushed, and cast), 41%; tungsten metal powder (including carbon- and hydrogen-reduced), 39%; chemicals, scheelite (for direct reduction to steel melts), and scrap, 11%; and ferrotungsten, 9%.

The consumption of purchased scrap, as reported to the Bureau of Mines, increased 5.7% in 1972 to about 615,000 pounds of contained tungsten compared with almost 582,000 pounds reported in 1971. Most of this scrap continued to be used in the consumption of cutting and wear resistant materials, welding rods and hard-facing materials, and superalloys.

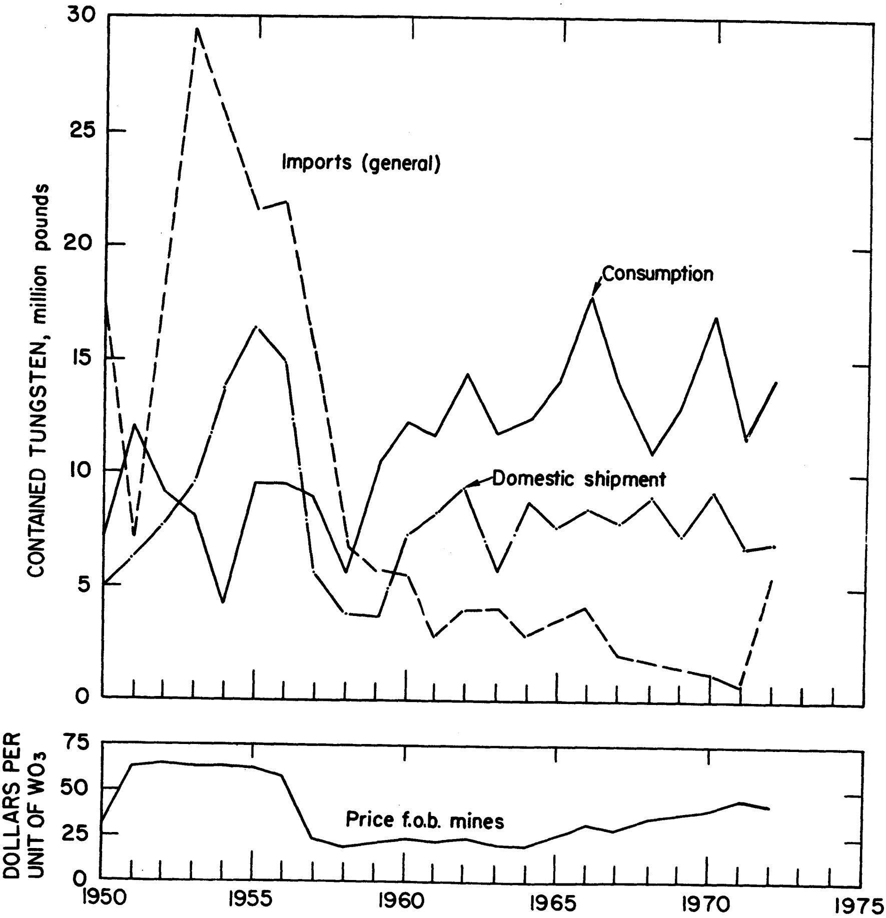

Figure 1.—Domestic shipments, imports, consumption, and average price of tungsten ore and concentrate.

Several special articles and reviews were published that evaluated tungsten supply-demand and consumption patterns, especially in metalworking and cutting applications.[8]

A comprehensive survey of world tungsten production and consumption based upon projected future demand and prices was conducted.[9] The study indicated the difficulty in obtaining complete information on international trade of tungsten concentrate and tungsten products.

Based upon a study conducted for GSA, a detailed analysis of the economics of the tungsten industry was made that evaluated the tungsten supply-demand relationship.[10] A portion of this report evaluated second-

[8] American Metal Market. International Tungsten Report. Sec. 2, Feb. 1, 1972, 16 pp.
———. Space Age Metals Section. Sec. 2, Mar. 14, 1972, 16 pp.
———. High-Temperature Alloys. Sec. 2, Nov. 22, 1972, 24 pp.
[9] Roskill Information Services Ltd. Tungsten: World Survey of Production and Consumption With Special Reference to Future Demand and Prices. Publ. by O. W. Roskill & Co. (Reports) Ltd. (London), Feb. 10, 1971, 112 pp.
[10] Burrows, James C. Tungsten: An Industry Analysis. (A Charles River Associates Research Study). Pub. by Heath Lexington Books, Lexington, Mass., 1971, 289 pp.

Table 4.—Production, shipments, and stocks of tungsten products in the United States

(Thousand pounds of contained tungsten)

	Hydrogen and carbon reduced metal powder	Tungsten carbide powder		Chemicals	Other [1]	Total
		Made from metal powder	Crushed and crystalline			
1971:						
Gross production during year	7,505	3,638	1,511	10,350	833	23,837
Used to make other products listed here	4,387	--	--	7,698	22	12,107
Net production	3,118	3,638	1,511	2,652	811	11,730
Shipments [2]	6,548	3,902	1,757	8,098	985	21,290
Producer stocks, Dec. 31	1,780	196	632	936	178	3,722
1972:						
Gross production during year	9,529	5,062	1,949	13,461	1,000	31,001
Used to make other products listed here	6,220	--	27	10,664	--	16,911
Net production	3,309	5,062	1,922	2,797	1,000	14,090
Shipments [2]	7,163	5,016	2,407	7,664	1,031	23,281
Producer stocks, Dec. 31	1,921	295	465	1,852	147	4,680

[1] Includes ferrotungsten, scheelite (produced from scrap), nickel-tungsten, self-reducing oxide, and pellets.
[2] Includes quantities consumed by producing firms for manufacture of products not listed here.

Table 5.—Major U.S. producers of tungsten concentrate and principal tungsten processors in 1972

Company	Location of mine, mill or processing plant
Producers of tungsten concentrate:	
Climax Molybdenum Co., subsidiary of AMAX	Climax, Colo.
Ranchers Exploration & Development Corp.[1]	Townsville, N.C.
Rawhide Mining Co	Fallon, Nev.
Transcon Corp	Mountain City, Nev.
Union Carbide Corp. (UCC), Mining & Metals Division [2]	Bishop, Calif.
Processors of tungsten:[3]	
Adamas Carbide Corp	Kenilworth, N.J.
Fansteel Inc	North Chicago, Ill.
General Electric Co	Cleveland and Euclid, Ohio, and Detroit, Mich.
G.T.E. Sylvania, subsidiary of General Telephone & Electronics Corp.	Towanda, Pa.
Kennametal Inc	Latrobe, Pa., and Fallon, Nev.
Li Tungsten Corp	Glen Cove, N.Y.
Teledyne Wah Chang Huntsville	Huntsville, Ala.
Union Carbide Corp., Mining & Metals Division	Niagara Falls, N.Y.
Westinghouse Electric Corp	Bloomfield, N.J.

[1] On standby status.
[2] UCC processes scheelite ore "straight through" to APT.
[3] Major consumers of concentrate and APT.

ary (scrap) tungsten supply and estimated that about 2 million pounds of tungsten are recovered annually from new and old scrap.

In October GE sold its refractory metal sheet rolling facility at Euclid, Ohio, to the Specialty Metals Division of AMAX.[11] The plant capacity to make close-tolerance rolled sheet and foil of high-temperature specialty metals was expanded.

Several studies conducted during the year evaluated the application of tungsten carbide in metalcutting uses.[12] These studies reflected the increased interest in tungsten carbide and tungsten carbide-base cutting materials reported statistically.

Mallory Composite Inc. was formed during the year by P.R. Mallory & Co. and

[11] American Metal Climax, Inc. Annual Report 1972, 40 pp.

[12] Iron Age. Carbide Slitting: When it Works and Why. V. 209, No. 7, Feb. 17, 1972, p. 52.

Journal of Metals. Recycled Tungsten Carbide Powder Inserts Outperform Premium Steel. V. 24, No. 1, January 1972, p. 7.

Mari, Albert. Pick Carbide Tools With Specific Task in Mind: Kalish. Am. Metal Market, June 12, 1972, p. 12.

Vaughan, Brian E. (ed.). Principles of Tungsten Carbide Engineering. Soc. of Carbide Eng., Bridgeville, Pa., 1972, 110 pp.

Table 6.—Consumption and stocks of tungsten products in the United States, by end use

(Thousand pounds of contained tungsten)

	Ferro-tungsten [1]	Tungsten metal powder [2]	Tungsten carbide powder	Other tungsten materials [3]	Total
1971:					
Steel:					
Stainless and heat resisting	80	W	--	107	187
Alloy	83	--	--	66	149
Tool	411	W	--	1,009	1,420
Cast irons	W	--	--	16	16
Superalloys	50	W	W	159	209
Alloys (exclude steels and superalloys):					
Cutting and wear resistant materials	W	975	3,915	192	5,082
Other alloys [4]	36	395	248	124	803
Mill products made from metal powder	--	2,027	2	15	2,044
Chemicals and ceramics	--	--	1	380	381
Miscellaneous and unspecified	108	410	71	280	869
Total	[5] 769	3,807	4,237	[5] 2,346	11,159
Consumer stocks Dec. 31, 1971	237	857	759	688	2,541
1972:					
Steel:					
Stainless and heat resisting	105	W	--	68	173
Alloy	110	W	--	47	157
Tool	865	W	--	586	1,451
Cast irons	2	--	--	12	14
Superalloys	96	141	W	192	429
Alloys (exclude steels and superalloys):					
Cutting and wear resistant materials	W	1,394	5,017	246	6,657
Other alloys [4]	55	698	353	111	1,217
Mill products made from metal powder	W	2,523	2	--	2,525
Chemicals and ceramics	--	--	1	178	179
Miscellaneous and unspecified	5	368	120	1	494
Total	1,238	5,124	5,493	1,441	13,296
Consumer stocks Dec. 31, 1972	289	650	716	466	2,121

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] Includes welding and hard-facing rods and materials and nonferrous alloys.

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

Composite Sciences, Inc., to market a flexible, cloth-like, wear-resistant coating of tungsten carbide under the name Formaflex.

Metco 72F–NS, a new tungsten carbide coating produced by plasma flame spraying, was developed by Metco Inc. and was reported to have doubled the operating life of other carbide coatings.

GE's Specialty Materials Dept. developed a new cutting material, designated Borazon CBN, in which synthetic cubic boron nitride material is sintered onto a cemented tungsten carbide base.[13]

Fansteel Inc., a leading producer of refractory metals including tungsten powder, tungsten alloys, and tungsten carbides, announced plans to build and operate a new research and development center, in cooperation with the University of Utah at Salt Lake City.[14] The center, which is scheduled to open in the fall of 1973, will conduct company-funded programs on new products and processes. Some areas of investigation are expected to include chemical vapor deposition (CVD), grain growth, oxidation of metals and carbides, and synthesis of silicon carbide.

PRICES AND SPECIFICATIONS

Throughout 1972 the domestic price of tungsten ore and concentrate continued to be quoted at $55 (nominal) per short ton unit, which reflected the GSA shelf price established for the Government's tungsten disposal program. As quoted in Metals Week and in the Metal Bulletin, the London price of tungsten concentrate shown

[13] Specialty Materials Dept., General Electric Co. Borazon CBN (Cubic Boron Nitride)—Information Manual. Worthington, Ohio, 1972, 250 pp.

[14] Fansteel Inc. Annual Report 1972. 16 pp.

in table 7, fell to a low of £14.00 per metric ton unit (about $30 per short ton unit depending upon the prevailing rate of exchange) during the year. The highest European quotation was reported at £17.50 per metric ton unit ($41.37 per short ton unit) in January.

The price of metallurgical-grade APT delivered to contract customers ranged from about $52 to $55 per short ton unit throughout 1972. A relatively small amount of special material (catalytic-grade APT and "Blue Oxide") was sold for about $57 to $59 per short ton unit. A conversion fee of about $11 per short ton unit was charged for toll processing tungsten concentrate to APT at a recovery of about 96%.

The quoted prices of both carbon- and hydrogen-reduced tungsten metal powder, f.o.b. shipping point, were unchanged during the year. Carbon-reduced tungsten metal powder (98.8% purity in 1,000-pound lots) was quoted by Metals Week at $4.50 per pound of contained tungsten. Hydrogen-reduced tungsten metal powder (99.99% purity) was quoted at $5.43 to $6.94 per pound of tungsten. Within this range, the price of tungsten was dependent upon the powder particle size, or Fisher number.

The quoted price of ferrotungsten in lots of 5,000 pounds or more, ¼-inch lump, packed, f.o.b. destination, continental United States, 70% to 80% tungsten, remained unchanged at $4.60 per pound of tungsten during the year. The quoted price of UCAR, the special high-purity ferrotungsten produced by Union Carbide Corp., was also unchanged during the year at $4.00 per pound of tungsten. During 1972, the U.S. dealer price of ferrotungsten was quoted in Metals Week at $4.50 (nominal) per pound of tungsten.

The price of scheelite concentrate for direct addition to steel melts, although not quoted, was believed to range from about $28 to $44 per short ton unit.

Table 7.—Monthly price quotations of tungsten concentrate in 1972

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	16.00	17.50	$37.83	$41.37	$39.20
February	16.00	17.00	37.81	40.21	39.01
March	15.50	17.00	36.70	40.19	38.32
April	15.50	16.50	36.69	39.16	37.90
May	14.00	16.20	33.16	38.41	35.70
June	15.20	16.20	35.47	38.40	36.99
July	15.10	16.20	33.52	36.01	34.72
August	14.65	16.20	32.51	36.04	34.31
September	14.40	15.75	31.97	34.98	33.51
October	14.00	15.55	29.98	34.17	31.99
November	14.00	16.60	29.78	35.42	31.60
December	15.40	16.60	32.86	35.31	34.15

[1] Equivalent high and low quotations as reported by Metals Week: Dependent upon the prevailing rate of exchange.
[2] Arithmetic average of weekly quotations. Equivalent 1972 average price $35.62; duty $3.97, equivalent average price, duty paid, $39.59 per short ton unit.

FOREIGN TRADE

Exports.—Exports of tungsten concentrate decreased by a factor of almost 21 to 95,000 pounds, estimated tungsten content, during 1972. Exports of ferrotungsten decreased 82%, and exports of APT increased 66% during the year. Effective January 1, 1972, export data on tungsten carbide powder, which previously had been in a "basket" category, was reported separately and is tabulated in table 11. Because official tungsten carbide export statistics are reported in gross weight, the estimated tungsten content was obtained by multiplying the gross weight by a factor of 0.78, which assumes that the contained weight of tungsten in mixed tungsten carbides averages 78%. There were no reexports of tungsten concentrate or other tungsten products, except APT, during the year. The reexports of APT totaled 84,700 pounds, gross weight, valued at $143,990 and were shipped entirely to West Germany.

Exports of unwrought tungsten metal and alloys in crude form, waste, and scrap in 1972 decreased 70% to 399,443 pounds, gross weight, valued at $539,389, and were shipped primarily to West Germany (72%), the Netherlands (7%), Canada and the United Kingdom (5% each), the Republic of South Africa (4%), and Switzerland and Sweden (2% each). Tungsten and tungsten alloy powder exports fell 19% during the year to 263,383 pounds, gross weight, valued at $1,205,139. This material was exported primarily to Belgium-Luxembourg (34%), Canada (20%), Austria (14%), Japan (8%), Finland and West Germany (5% each), and Sweden (3%).

Tungsten and tungsten alloy wire exports in 1972 increased almost 19% to 141,780 pounds, gross weight, valued at $3,014,806, and were shipped primarily to West Germany (22%), Canada (13%), Belgium (12%), the United Kingdom (11%), Japan (10%), Brazil (7%), Mexico (6%), and Sweden and Singapore (5% each). Exports of wrought tungsten and tungsten alloys increased 26% to 88,812 pounds, gross weight, valued at $1,356,071. Most of this material was shipped to West

Table 8.—U.S. exports of tungsten ore and concentrates, by country

(Thousand pounds and thousand dollars)

Country	1971			1972		
	Gross weight	Tungsten content [1]	Value	Gross weight	Tungsten content [1]	Value
Canada	94	48	211	--	--	--
France	100	52	220	--	--	--
Germany, West	1,864	962	3,752	--	--	--
India	170	88	245	--	--	--
Ireland	--	--	--	(2)	(2)	(2)
Japan	293	151	559	--	--	--
Netherlands	357	184	657	116	60	161
Sweden	267	138	402	--	--	--
United Kingdom	742	383	1,277	67	35	50
Total	3,887	2,006	7,323	183	95	211

[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 ammonium paratungstate, by country

(Pounds)

Country	1971		1972	
	Gross weight	Value	Gross weight	Value
Australia	519	$1,038	--	--
Chile	384	787	--	--
Colombia	--	--	1,017	$2,033
Ecuador	--	--	750	2,668
France	--	--	437	874
Germany, West	53,850	157,543	89,600	170,039
Guatemala	--	--	863	1,230
Haiti	689	1,378	--	--
Honduras	499	948	--	--
Ireland	--	--	657	1,314
Japan	--	--	1,042	2,084
Lebanon	1,286	2,000	--	--
Mexico	--	--	250	500
Sweden	200	624	--	--
Syrian Arab Republic	--	--	864	1,728
Total	57,427	164,318	95,480	182,470

Table 10.—U.S. exports of ferrotungsten, by country

Country	1971 Pounds (gross weight)	1971 Pounds (estimated tungsten content)	1971 Value	1972 Pounds (gross weight)	1972 Pounds (estimated tungsten content)	1972 Value
Brazil	1,886	1,509	$7,544	--	--	--
Canada	14,646	11,717	58,584	20,270	16,216	$81,066
France	1,620	1,296	6,481	--	--	--
Germany, West	1,952	1,561	7,808	--	--	--
Italy	22,046	17,637	70,000	--	--	--
Japan	45,172	36,138	157,028	--	--	--
Mexico	11,020	8,816	34,024	--	--	--
Sweden	22,000	17,600	69,900	--	--	--
Venezuela	--	--	--	986	789	3,700
Total	120,342	96,274	411,369	21,256	17,005	84,766

Table 11.—U.S. exports of tungsten carbide powder

Country	Pounds (gross weight)	Pounds (estimated tungsten content)	Value
Argentina	100	78	$669
Australia	30,148	23,515	68,364
Austria	13,968	10,895	67,301
Belgium-Luxembourg	4,336	3,382	35,967
Brazil	2,407	1,877	23,447
Canada	237,941	185,594	609,285
Chile	7,792	6,078	1,350
Costa Rica	9,936	7,750	4,126
Denmark	450	351	1,848
France	27,665	21,579	64,548
Finland	50	39	746
Germany, West	62,996	49,137	503,419
Ireland	22	17	982
Israel	21,459	16,738	101,875
Italy	29,745	23,201	248,876
Japan	22,656	17,672	62,215
Libya	100	78	608
Mexico	129,770	101,221	244,628
Netherlands	25,601	19,969	151,027
Portugal	60	47	654
South Africa, Republic of	1,718	1,340	14,479
Sweden	13,529	10,553	20,966
Switzerland	11,619	9,063	76,869
Turkey	90	70	1,373
United Kingdom	8,084	6,305	36,136
Venezuela	800	624	3,680
Total	663,042	517,173	2,345,438

Germany (26%), Canada (19%), Italy and the United Kingdom (10% each), Mexico (7%), Belgium-Luxembourg (5%), and France and Sweden (4% each).

Imports.—Imports for consumption of tungsten concentrate during 1972 increased by a factor of almost 14 to a 14-year high of 5.7 million pounds of contained tungsten.

During the year imports of tungsten carbide, from West Germany (74%), Canada (14%), and Sweden (12%), increased 94% and totaled 256,473 pounds of contained tungsten valued at $1,415,814. Imports of waste and scrap containing over 50% tungsten increased by a factor of over 8 and totaled 121,964 pounds of tungsten valued at $342,009. This material was received primarily from the Netherlands (33%), Japan (21%), West Germany (18%), Canada (12%), and France (11%). Imports of unwrought tungsten (except alloys) in lump, grain, and powder rose 42% to 141,390 pounds of contained tungsten valued at $577,114 and were obtained from West Germany (92%), the United Kingdom (5%), and Sweden (3%). Imports of unwrought tungsten, n.e.c. (not elsewhere classified), which totaled 39,264 pounds, gross weight, valued at $133,269, were received from West Germany (76%) and the United Kingdom (24%). Wrought tungsten imports during the year totaled 5,515 pounds, gross weight, valued at $386,781. This material was imported primarily from the Netherlands and Japan (32% each), and Austria (25%).

In 1972, imports of tungsten material classified as "metal-bearing materials in chief value of tungsten," all from the Republic of Korea, increased by a factor of almost three and totaled 100,884 pounds of contained tungsten valued at $179,911. The material imported under this classification was believed to be synthetic scheelite having an average grade of 70% WO_3. Ferrotungsten imports increased by a factor of over 27 during the year to 800,000 pounds tungsten content, and were received primarily from the United Kingdom (42%), Canada (23%), Portugal (13%), and West Germany (11%).

Imports of calcium tungstate, almost all from West Germany, increased by 79% and totaled 27,296 pounds of contained tungsten valued at $272,186. Imports classified as "mixtures to two or more inorganic compounds in chief value tungsten" fell

Table 12.—U.S. imports [1] of tungsten ore and concentrates, by country

(Thousand pounds and thousand dollars)

Country	1971			1972		
	Gross weight	Tungsten content	Value	Gross weight	Tungsten content	Value
Australia	101	58	140	695	392	951
Bolivia	--	--	--	1,568	880	1,624
Brazil	55	31	71	223	123	251
Canada	334	203	426	2,721	1,634	3,507
Germany, West	--	--	--	975	257	588
Guatemala	3	(2)	1	--	--	--
Kenya	--	--	--	91	54	234
Korea, Republic of	--	--	--	641	370	734
Malaysia	--	--	--	288	166	354
Mexico	174	93	290	198	107	218
Peru	322	192	556	1,162	670	1,162
Portugal	--	--	--	14	9	24
Rwanda	--	--	--	121	72	133
Thailand	--	--	--	1,903	1,069	2,323
Zaire	--	--	--	175	95	213
Total	989	577	1,484	10,775	5,898	12,316

[1] Data are "general imports", that is, they include tungsten imported for immediate consumption plus material entering warehouses.
[2] Less than ½ unit.

Table 13.—U.S. imports for consumption of tungsten ore and concentrates, by country

(Thousand pounds and thousand dollars)

Country	1971			1972		
	Gross weight	Tungsten content	Value	Gross weight	Tungsten content	Value
Australia	101	58	140	695	392	951
Bolivia	--	--	--	1,390	780	1,443
Brazil	--	--	--	223	124	265
Canada	334	203	426	2,721	1,634	3,507
Germany, West	--	--	--	975	257	588
Guatemala	3	(1)	1	--	--	--
Kenya	--	--	--	91	54	234
Korea, Republic of	--	--	--	641	370	734
Malaysia	--	--	--	288	166	354
Mexico	156	81	219	165	90	200
Peru	119	76	247	1,407	814	1,516
Portugal	--	--	--	14	9	24
Rwanda	--	--	--	176	100	191
Thailand	--	--	--	1,581	883	1,976
Zaire	--	--	--	120	66	156
Total	713	418	1,033	10,487	5,739	12,139

[1] Less than ½ unit.

Table 14.—U.S. imports for consumption of ferrotungsten, by country

Country	1971			1972		
	Pounds (gross weight)	Pounds (tungsten content)	Value	Pounds (gross weight)	Pounds (tungsten content)	Value
Austria	--	--	--	30,864	24,691	$64,400
Brazil	13,071	9,281	$29,467	--	--	--
Canada	--	--	--	238,595	189,643	501,288
France	--	--	--	12,787	10,024	27,171
Germany, West	--	--	--	114,580	88,171	228,077
Norway	--	--	--	9,000	6,975	19,844
Portugal	--	--	--	126,103	104,737	275,284
Sweden	24,121	20,392	68,688	55,115	44,935	110,019
United Kingdom	--	--	--	427,980	344,746	943,143
Total	37,192	29,673	98,155	1,015,024	813,922	2,169,226

Table 15.—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
1970	35	173	190	1,560	225	1,733
1971	r 33	117	r 257	1,804	r 290	1,921
1972	133	342	514	2,560	647	2,902

r Revised.

Table 16.—U.S. import duties on all forms of tungsten

Tariff classification	Article	Rate of duty effective Jan. 1, 1973	
		Non-Communist countries	Communist countries
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 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.

23% to 28,669 pounds, tungsten content valued at $187,070 from Canada (65%) and West Germany (35%). Under the classification "other tungsten compounds, n.e.c.," 13,425 pounds, contained tungsten, were imported primarily from Canada (86%) and West Germany (12%). There were no reported imports of tungstic acid, ammonium tungstate, or potassium tungstate during the year.

The U.S. import duty on tungsten concentrate (table 16) on material from non-Communist countries was $3.97 per short ton unit while the duty applicable to material from Communist countries was $7.92 per short ton unit. To promote U.S. trade between the U.S.S.R. and the People's Republic of China consideration reportedly was given to providing these two Communist countries "most favored nation" status.

WORLD REVIEW

The Working Group, a subsidiary of the Committee on Tungsten of the United Nations Conference on Trade and Development (UNCTAD), met in Geneva, Switzerland, during June to discuss methods of stabilizing the low world price, obtaining more detailed ore reserve data, and evaluating statistical data on tungsten trade and product consumption. The People's Republic of China, which had been admitted to the UN in 1971, was invited to attend the meeting of the Working Group as an observer. The Committee staff continued to canvass, tabulate, and report tungsten statistics in the quarterly bulletin Tungsten Statistics.

Table 17.—Tungsten: World production by country

(Thousand pounds of contained tungsten [1])

Country	1970	1971	1972 [p]
North America:			
Canada [2]	[r] 2,956	3,667	3,931
Guatemala [e]	90	90	90
Mexico	635	899	798
United States	[r] 9,625	6,900	8,150
South America:			
Argentina	317	302	[e] 310
Bolivia [3]	4,068	4,608	4,923
Brazil	2,549	3,082	[e] 2,750
Peru	1,773	1,698	1,888
Europe:			
Austria	187	99	--
France	[r] 174	1,922	1,237
Portugal	[r] 2,390	2,176	3,049
Spain	899	897	648
U.S.S.R. [e]	14,800	15,400	15,900
Africa:			
Niger	2	[e] 2	--
Nigeria	[e] 2	[e] 2	2
Rhodesia, Southern [4]	225	516	330
Rwanda [e]	400	440	570
South Africa, Republic of	7	15	2
South-West Africa, Territory of [5]	139	209	196
Tanzania	7	9	15
Uganda	[r] 267	243	240
Zaire	[r] 416	709	[e] 680
Asia:			
Burma	[r] 487	842	904
China, People's Republic of [e]	[r] 13,200	[r] 15,400	15,400
India	40	33	37
Japan	[r] 1,882	2,332	2,493
Korea, North [e]	[r] 4,740	[r] 4,740	4,740
Korea, Republic of	4,564	4,539	4,478
Malaysia	[r] 154	20	[e] 276
Thailand	[r] 1,565	5,527	7,370
Oceania:			
Australia	2,789	3,411	3,371
New Zealand	11	15	15
Total	[r] 71,360	[r] 80,744	84,793

[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] Producer's shipments; actual production data is not officially reported, but available company figures indicate a substantial difference between actual output and shipments in some years.
[3] Data are the sum of production by COMIBOL and exports by medium and small mines.
[4] Data are for the Beardmore mine only, and are for the year ended September 30 of the year stated.
[5] Data are for the South West Africa Co. Ltd. only, and are for the year ended June 30 of the year stated.

Table 18.—Tungsten: World concentrate consumption, by country

(Thousand pounds of contained tungsten)

Country [1]	1970	1971	1972 p
Actual consumption:			
Australia	88	88	88
Austria	4,387	3,417	3,109
Canada	e 441	e 500	e 500
Czechoslovakia	e 3,084	e 2,900	e 3,000
India	340	412	390
Japan	8,962	4,579	5,128
Portugal	763	498	679
Sweden	3,289	3,228	2,478
United Kingdom	8,691	4,819	7,205
United States	16,700	11,622	14,107
Apparent consumption, including stock variations: France	3,192	2,467	2,734
Apparent consumption, excluding stock variations:[2]			
Argentina	86	84	106
Belgium-Luxembourg	64	49	62
Brazil	441	463	494
Bulgaria e 3	r 75	75	75
China, People's Republic of e 3	r 3,500	4,000	5,000
Germany:			
East e 3	850	750	700
West	7,112	5,324	5,668
Hungary e 3	50	50	50
Italy	152	126	110
Korea, North e 3	3,500	3,500	3,500
Netherlands	496	613	1,581
Poland	3,924	3,876	3,993
Romania e 3	20	30	30
South Africa, Republic of	r 611	509	500
Spain	r 170	203	210
U.S.S.R. e 3	14,650	14,200	14,700
Total	r 85,638	r 68,382	76,197

e Estimate. p Preliminary. r Revised.
[1] In addition the following countries may consume tungsten concentrate but specific data are not available: Denmark, Finland, Israel, Norway, Switzerland, and Yugoslavia.
[2] Production plus imports minus exports.
[3] Estimated by author of chapter.

Primary source: UNCTAD Committee on Tungsten and Annual Company Reports.

Australia.—About 70% of the country's tungsten production was supplied by King Island Scheelite Ltd., a subsidiary of Peko-Wallsend Ltd. During the year, almost 4 million short tons of overburden and ore material were mined by open pit operations. The 319,600 tons of recovered ore had an average grade of 0.63% WO_3 and was treated to produce 148,920 short ton units of WO_3.[15]

The 3,668,000 tons of overburden removed from the tungsten operations on King Island during the year were used to complete the breakwater and new harbor near the company town of Grassy.

An evaluation of the open pit tungsten reserves indicated a mine life of about 5 years under current mining and milling practices. Future underground operations are expected to be conducted to recover scheelite from the deposit, which extends under the sea.

King Island's expansion program, which was to have doubled production within 3 years, was discontinued due to depressed world prices. However, the development of underground mining operations was continued during the year.

Tungsten concentrate was produced from wolfram ore recovered from underground operations at Rossarden in northeastern Tasmania by Aberfoyle Ltd.[16] Tungsten was also recovered from the mine of Storeys Creek Tin Mining Co. N.L., a tungsten-tin producer owned entirely by Aberfoyle. Late in 1971 the mill at the Storeys

[15] Peko-Wallsend Ltd. (Sydney, Australia). Annual Report 1971–72. 32 pp.
Research and Statistical Bureau, the Sydney Stock Exchange Ltd. (Sydney, Australia). Company Review: Peko-Wallsend Ltd. Nov. 8, 1972, 13 pp.
———. (Sydney, Australia). Supplementary Company Review: Peko-Wallsend Ltd. May 9, 1973, 10 pp.
[16] Aberfoyle Ltd. (Melbourne, Australia). Annual Report 1971–72. 13 pp.
Research and Statistical Bureau, The Sydney Stock Exchange Ltd. (Sydney, Australia). Company Review: Aberfoyle Ltd., Oct. 23, 1972, 7 pp.
———. (Sydney, Australia). Supplementary Company Review: Aberfoyle Ltd. April 10, 1973, 6 pp.

Creek mine was closed down, and all ore in 1972 was sent to the nearby Aberfoyle mill for treatment and concentrating.

At Wolfram Camp, Queensland, tungsten concentrate was recovered from wolfram ores by Metals Exploration N.L. Scheelite ore, recovered by Mareeba Mining and Exploration Pty Ltd. at its Mount White lease, was concentrated at the Irvinebank custom mill. R.B. Mining Pty Ltd. reopened a number of old shafts and installed rail tracks to provide transportation by ore cars.

Bolivia.—Empresa Nacional de Fundiciones (ENAF), the Bolivian national smelting company, and the Czechoslovakian firm Skoda Export signed an agreement whereby Skoda will conduct a feasibility study of installing a ferroalloy plant near Lake Titicaca. It is anticipated that the plant would produce about 550 tons of ferrotungsten (about 0.9 million pounds of contained tungsten) annually.

After visiting the major Bolivian tin-tungsten mines, the privately owned Chojilla mine, and the state-owned Bolsa Negra and Kami mines, Skoda's technicians estimated that Bolivian tungsten reserves were sufficient to last for about 50 years.

Brazil.—A cost evaluation study of the major tungsten deposits in Northeast Brazil was published.[17] Of the some 250 to 300 scheelite-bearing deposits located in central and western Rio Grande do Norte, northern Paríba, and eastern Ceará, most of the Brazilian production comes from four underground mines. The largest producer, the Brejuí mine, upgrades 300 tons of ore per day containing 0.70% WO_3 to commercial-grade concentrate averaging 70% WO_3. The overall recovery of the Brejuí mill averages 80% and supplies about 57% of the country's production.

The Barra Verde mine and mill supplies about 26% of Brazilian tungsten production from scarn-scheelite ores, which are recovered from deep deposits and processed at a rate of 100 tons per day to 70% WO_3 concentrate. The Cafuca and Bodo mines recover tungsten from narrow, high-grade ore deposits containing from 1% to 2% WO_3 and process the ores at rates between 25 and 50 tons per day. The remaining deposits are primarily intermittently worked open pit operations. Concentration is done by hand crushing, screening, and jigging. The recovery of scheelite by primitive hand concentration methods is not greater than 40%.

Approximately 80% of the Brazilian production is exported to the United Kingdom, West Germany, Austria, France, Belgium-Luxembourg, Sweden, and Japan. The remaining 20% is consumed almost entirely in the Brazilian steel industry.

Canada.—Although continuous high-quality scheelite operations were maintained throughout the year by Canada Tungsten Mining Corp. Ltd. (CTMC), the country's major tungsten producer, at Tungsten, Northwest Territories, 1972 production fell about 3.5%. Mine production, all from open pit operations, totaled 158,706 short ton units of WO_3 (2.5 million pounds of contained tungsten), and the concentrator operated at 92.53% of possible time treating an average of 472 short tons per day.[18] Overall mill recovery of WO_3 averaged 79.83% during the year. The newly mined ore had a higher chert content and caused additional metallurgical processing problems. Mill circuit modifications alleviated most of the problems caused by the chert material. The average grade of ore processed decreased slightly and was 1.15% WO_3 in 1972, compared with an average grade of 1.19% WO_3 in 1971.

In addition to the scheelite concentrate, 225,125 pounds of byproduct copper in concentrate was produced during the year, a decrease of 7% compared with that of 1971.

At yearend CTMC estimated its reserves of scarn-type ore in place at about 240,000 tons averaging 1.65% WO_3. In addition, 157,600 tons of scheelite ore averaging 1.06% WO_3 was stockpiled. The reserves and the stockpile material contain approximately 8.9 million pounds of tungsten, which, if all was recovered, would be sufficient to sustain 3 to 4 years production at the current rate.

An accelerated deep drilling exploration program completed in the 1972 season outlined a new mineralized zone of tungsten ore. The ore body was of sufficient importance to warrant driving an adit for about 4,000 feet. Upon completion, an evaluation will be made of the feasibility of conduct-

[17] Barbosa, Frederico L. M. Financial Analysis of Tungsten Deposits in Northeast Brazil. M. S. Thesis (T 1411), Colorado School of Mines, Golden, Colo., 1972, 83 pp.

[18] Canada Tungsten Mining Corp. Ltd. (Toronto, Canada). Annual Report 1972. 9 pp.

ing underground mining operations, which might allow mining to be conducted on a year-round basis. The open pit mining season is restricted by the severe climate to about 5 months per year, primarily during the summer. If underground mining operations are to be conducted, it is anticipated that additional milling facilities will be required.

During the 1972 mining season, a total of 203,551 tons of ore containing an average of 1.05% WO_3 was mined, crushed, and stockpiled. In addition, 297,240 tons of waste was removed from the pit area. The main changes in mining practices developed during the year were improved methods of stockpiling and of blending tungsten concentrate.

CTMC's Vancouver Leach Plant in North Vancouver, British Columbia, continued to operate continuously throughout the year on a 5-day-per-week schedule to upgrade scheelite concentrate received from the mine and mill. Overall recovery of the leach plant remained good and averaged 97.1% in 1972, a slight decrease from the 98% recovery reported in 1971.

During the year, the Canex Tungsten Division of Placer Development Ltd. continued to recover tungsten from its Invincible scheelite property at Salmo, near Trail, British Columbia. The Canex mill treated a total of 198,000 tons of ore averaging 0.58% WO_3 at an average rate of 529 tons per day with a recovery of 81.5%.[19] Approximately one-fifth of this material was recovered as a high-grade table concentrate. In 1972, the average price received for tungsten concentrate fell to $34.05 per short ton unit of WO_3, f.o.b. Vancouver. As a result of reduced sales, mill stocks more than doubled and totaled 53,275 units (0.85 million pounds of contained tungsten).

Yearend reserves of broken and unbroken scheelite ore at Salmo totaled 104,000 tons at an average grade of 0.55% WO_3. It is expected that this reserve will be depleted by mid-1973 at which time the operation will be terminated.

China, People's Republic of.—Analyses of the People's Republic of China (PRC) export statistics, as reported by its trading partners, indicated that exports of tungsten concentrate decreased because the PRC was producing less and consuming more concentrate in the country's growing steel industry. There was no indication that the PRC was stockpiling tungsten concentrate in significant quantities. It is believed that most of the easily located rich surface deposits have been depleted. Future production will be supplied primarily from low-grade tungsten ore recovered from deep underground operations. Domestic consumption is expected to continue to increase and may be approaching 5.7 million pounds of contained tungsten annually to meet the rising needs for cutting tools, drill bits, and specialty tool steels.[20] The PRC will probably not resume previous high levels of tungsten production during the 1970's.

Tungsten mining requires a continuous influx of capital to maintain a stable production level because operators must be constantly moving on to new ore pockets. Since the early 1960's improvements and expansions reported at tungsten mines and mill sites have been neglegible and have resulted in decreasing levels of production in the PRC.

Although tungsten mining and ore dressing in the PRC are generally primitive the major mines in Kiangsi and Kwangtung provinces reportedly recover tungsten from wolframite ores by mechanized techniques. Large scheelite deposits have been discovered in Hunan Province.

Exports of tungsten concentrate to the U.S.S.R. from PRC which decreased substantially from about 21,000 tons (gross wt.) in 1960 to zero in 1968, were resumed in 1970 and had increased by a factor of almost 7 in 1972 as indicated below:

Year	Shipments of tungsten concentrate from PRC to U.S.S.R.	
	Gross weight (tons)	Estimated tungsten content [1] (1,000 lb.)
1972 p	5,786	6,243
1971	5,282	5,699
1970	881	951
1969	0	0
1968	0	0

p Preliminary.
[1] Assumed 68% WO_3 content; conversion factor: $=0.68 \times 0.7931 \times 2000 = 1079$ lb. W (est.)/st (gross wt.).

[19] Placer Development Ltd. (Vancouver). Annual Report 1972. 32 pp.
[20] Canadian Min. J. Tungsten. V. 94, No. 1, January 1973, p. 24.

France.—During the year Sté. Minière d'Anglade processed tungsten ore having an average content of 1.39% WO_3 at its mill adjacent to the Salau (Ariège) ore body. Mill production in 1971 was of two different grades: 75% WO_3 concentrate and 30% WO_3 semiconcentrate. Additional mill facilities were installed in 1972 in an attempt to upgrade the WO_3 content of the semiconcentrates and increase production. Sté. Minière et Métallurgique du Chatelet produced tungsten concentrate at its Enguiales exploitation in Aveyron.

Korea, Republic of.—Because the Republic of Korea has historically been a major producer of tungsten concentrate, the country has indicated interest in establishing concentrate processing facilities and in the development of a domestic tungsten carbide cutting tool industry.

The Sangdong mine of Korea Tungsten Mining Co., Ltd., (KTMC) which is 15.5% Government owned, continued to be the country's major tungsten producer in 1972 and accounted for over 88% of the domestic supply as shown in the following tabulation:[21]

Company	Short tons (gross weight)
Bando Mining Co., Ltd	10
Kaya Ind. Co., Ltd	56
Korea Tungsten Mining Co., Ltd.	
Dalsong mine	63
Sangdong mine	3,568
Okbang Mining Co., Ltd	314
Ssangjon Mine	10
Wolak Mining Co., Ltd	6
Other companies (10 mines)	7
Total	4,034

A plant for processing tungsten concentrate to APT was completed by KTMC in December adjacent to its Sangdong mine and mill. When in full-scale operation, this plant is expected to have capacity for processing about 100,000 short ton units of WO_3 (almost 1.6 million pounds of tungsten per year).

Malaysia.—There was a substantial increase by a factor of almost 16 in the recovery of tungsten concentrate from West Malaysia tin tailings.[22] Beh Minerals, the leading company in this field, has added tungsten and other heavy mineral extraction mechanisms on line at the end of its tin processing shed.

Portugal.—Preliminary reports indicated that tungsten production increased by about 3% during 1972. Because of the depressed market prices and the lower grade of ore mined, it was uneconomical for the major producer, Beralt Tin and Wolfram Ltd., to sell high-grade (74% WO_3) wolframite concentrate recovered from its Panasqueira ore body in central Portugal.[23] The bulk of this material was stockpiled. Proven and inferred tungsten ore reserves at Panasqueira were reportedly sufficient to provide a mine life of about 9 years.

Further consideration was given to the possible establishment of a tungsten processing plant in Portugal, but, because of the depressed tungsten market, it was decided to defer action until a later date.

Production of ferrotungsten containing 82.9% tungsten increased 23% to 370 tons during the year. This material represented over 90% of reported Portuguese tungsten concentrate consumption.

Rhodesia, Southern.—In 1972, Rhodesian tungsten production fell by over 20% and was obtained primarily from the Beardmore mine, operated by the Messina (Transvaal) Development Co., Ltd., in the Victoria district near Bikita.[24] A total of 44,300 short tons of ore grading 0.64% WO_3 was mined at Beardmore and 38,600 tons of ore containing about 0.72% WO_3 was milled during the year. Overall recovery averaged 73.5% and 314 tons of scheelite concentrate containing 209 tons of WO_3 (0.3 million pounds of contained tungsten was produced.

At yearend, the Beardmore ore reserve totaled 35,300 tons averaging 0.64% WO_3. Since exploration programs failed to uncover additional worthwhile tungsten mineralization the mine will be forced to close in the fall of 1973 when present ore reserves are exhausted.

A slime treatment plant was erected adjacent to the Beardmore mine and was

21 U.S. Embassy, Seoul, Rep. of Korea. Tungsten Stocks. State Department Airgram A-190, June 8, 1973, 1 p.

22 U.S. Embassy, Kuala Lumpur, Malaysia. Industrial Outlook Report: Minerals. State Department Airgram A-104, June 15, 1973, 12 pp.

23 Beralt Tin and Wolfram Ltd. (London). Annual Report 1972. 19 pp.

Charter Consolidated Ltd. (London). Annual Report 1972. 51 pp.

———. Annual Report 1973, 50 pp.

24 The Messina (Transvaal) Development Co., Ltd. Johannesburg, (Republic of South Africa). Annual Report 1972. 28 pp.

scheduled to become operational in February 1973 with a processing capacity of 2,200 tons of low-grade slimes per month. The total capital expenditure which will be incurred in the plant construction was expected to be about $75,000.

Total tungsten production at the Beardmore complex (mine, mill, and slime treatment plant) in 1973 was expected to increase about 3% and total 215 tons of WO_3 contained in 331 tons of concentrate. This material will be recovered by milling 35,300 tons of ore from the Beardmore mine and by processing 20,900 tons of low-grade slimes at the new treatment plant.

South Africa, Republic of.—Hard Metals Ltd., a subsidiary of Anglo American Corp. of South Africa Ltd., was the country's only producer of tungsten carbide from ore.[25] Hard Metals previously imported its tungsten concentrate starting material from South Korea but currently obtains almost all its requirements from African sources. The major supplier, Messina (Transvaal) Development Co., Ltd., provides scheelite concentrate averaging 68% WO_3 from its Beardmore mine in Southern Rhodesia, which borders South Africa.

South-West Africa, Territory of.—The country's major tungsten producer, Brandenburg West, operated by the South West Africa Company Ltd., continued to recover tungsten from mixed tin-tungsten concentrates obtained by open pit mining operations.[26] Although native miners were on strike for about 3 months, the volume of the tin-tungsten concentrate produced during the year increased about 7%. Although the average grade of tungsten concentrate fell 13% to 17.66% WO_3, the average grade of tin concentrate increased slightly to 33.58% tin. Additional mine loading equipment was obtained to expedite overburden removal and facilitate ore handling.[27] Other capital expenditure made was associated with the replacement of the vibrating screen in the jigging circuit of the gravity recovery plant.

At yearend, the ore reserve at Brandenburg West was estimated at about 6.8 million tons having an average grade of 0.153% tin and 0.069% WO_3.

Development and construction of the underground Krantzburg scheelite mine and adjacent mill located about 100 miles northwest of Windhoek were conducted during the year. The mill was designed to treat about 7,500 net tons of ore per month and, when operational, concentrate production (65% WO_3) was expected to total about 50 net tons per month. The ore reserves of this property, which will be operated by Nord Resources Corp., have not been fully determined. Preliminary investigations indicated an ore body sufficient to provide a mine life of 8 to 10 years.

Spain.—A detailed evaluation of the present and projected Spanish mineral industry was conducted by the Office of the Director General of Mines in the Ministry of Industry. Four of the nine tungsten mines in operation during the year provided two-thirds of the Spanish production. Three of the mines, Santa Comba, San Finx, and Monte Neme, are located in the western end of the Province of La Coruna in the northwestern corner of Spain and each produces about 14% of the country's total tungsten output. The major domestic tungsten operation, the Merladet mine and mill, supplys about 25% of the total Spanish production in the form of high-grade scheelite concentrate having a guaranteed content of 75% WO_3 and low impurity levels.[28]

Electrometalúrgia del Agueda of Spain evaluated plans for producing tungsten metal from domestic concentrate by the aluminothermic process.

Sweden.—Evaluations of AB Statsgruvor's newly developed Postman scheelite deposit at Elgfall in central Sweden were conducted during the year and ore was taken a few miles to the company's tungsten mine and ore dressing plant at Yxsjöberg where both a high-grade concentrate, containing about 73% WO_3, and a low-grade

---

25 Metal Bulletin Monthly (London). South Africa Report. No. 17, May 1972, pp. 7–15.

26 The South West Africa Co., Limited (London). Annual Report 1972. 24 pp.

27 Williams, A.R.O. The South West Africa Co., Ltd. Financial Times (London), No. 25911, Nov. 17, 1972, p. 4.

28 Direccion General de Minas. Plan Nacional de la Mineria (National Mining Plan). Capitulo I, Programa Nacional de Investigación Minera—Mapa Metalogenético. (Ch. I, National Program of Mineral Investigation—Metallogenic Maps). 1971, 157 pp. and maps; Capitulo II, Programa Nacional de Explotación Minera—Minería de Minerales Metálicos Varios. (Ch. II, National Program of Mineral Exploitation—Mining of Various Metallic Minerals). 1971, pp. 245–289.
Metal Bulletin (London). Scheelite-Highest Quality Merladet Brand. No. 5744, Oct. 24, 1972, p. 43.

semiconcentrate, containing about 35% WO_3, were produced.

Sandvikens Jernverks AB and Fagersta AB both consumed tungsten concentrate (scheelite) in the production of cemented tungsten carbides and specialty steels. Sandviken originally obtained much of its scheelite concentrate from Canada (CTMC).

Thailand.—Production and exports of tungsten concentrate increased substantially and replaced fluorite as the second major Thai mineral foreign exchange earner in 1972.[29] Although difficulties with lawlessness, corruption, poaching, and smuggling continued to plague the mineral industry, preliminary Government forecasts for 1973 were optimistic. An initial report of the West German Geological Mission indicated promising areas of tungsten mineralization in the central and western portions of northern Thailand. About 90% of the country's nine tungsten mines and 179 tin-tungsten mines, located primarily in the southern part of the country, were plagued by illegal diggers on the sites.

U.S.S.R.—A detailed review of byproduct tungsten extractive and processing metallurgy operations at the Tyrhy-Auzsk ore dressing plant in the northern Caucasus was reported.[30] A computer and an automatic sampler are being installed that will continuously record tungsten and impurity contents, will record the main technological indices of the plant operation, and automatically make necessary corrections in operating procedures.

The U.S.S.R. initially announced plans to increase production of tungsten concentrate by 60% during the 9th Five Year Plan, 1971–75. While production in 1971 was believed to have been 4% higher than in 1970, production in 1972 was estimated to have increased about 3%.

When the Primorsky (Maritime) Kray production facility in the Far East is completed it is scheduled to contribute much of the increase in tungsten output planned during 1971–1975. The Vostok (East) Combine, a large mining and concentrating operation located on the western slope of the Sikhote-Alin' mountains in the region near the Iman and Tatibe Rivers has been under construction since 1967. Some tungsten ore was believed to have been trucked to this facility and processed in late 1972. Another significant tungsten deposit has been discovered in the vicinity of Luchegorski close to the Trans-Siberian Railroad right-of-way. The rich ore of this deposit is amenable to open-pit mining and production is scheduled to start in 1974.

Facilities for the recovery of tungsten ore are to be put in operation in 1973 at the Solnechnyy copper concentrator in Khabarovsk Kray to exploit material mined from deposits in the Myao Chan foothills. Near the end of 1972, a mine was under construction near the Balkhash mining and metallurgical complex in Kazakhstan to produce tungsten and coproducts molybdenum and bismuth. Exploitation and development of the Maykhura tungsten deposit in Tadzhikstan is also scheduled to begin during the current 5-year plan. In the Buryat ASSR extensive investigation of the Inkurskiy deposit during 1966–70 permitted work to be started on the development of new mines to support operations at the Dzhida tungsten-molybdenum processing combine which began operation of a new ore dressing facility early in 1972. It was announced in 1972 that plans had been prepared for the reconstruction of the concentrator at Tyrny-Aux which permit an increase in the ore throughput of 3 million tons per year. Plans for the construction of additional mines and concentrating facilities at Ingichka in Uzbekistan were also announced.

To supplement domestic supplies the Soviets have imported tungsten concentrate, primarily from the People's Republic of China which, after cutting off exports to the U.S.S.R. in the mid 1960's, resumed them in 1970.

When the supply of tungsten in the U.S.S.R. was restricted, its use, primarily in the tool steel industry, experienced a dramatic shift in 1967 and subsequent years as molybdenum replaced tungsten in tool steels.[31]

United Kingdom.—Primarily as a result of the low European price of tungsten

---

29 U.S. Embassy, Bangkok, Thailand. Industrial Outlook Report: Minerals. State Department Airgram A-134, May 18, 1973, 13 pp.

30 Adamov, E. V. Practice of Ore Dressing of Non-Ferrous, Rare and Precious Metals in the Plants of the U.S.S.R. (TT 71-58012), Nat. Tech. Inf. Service, Springfield, Va., 1972, pp. 165–177.

31 American Metal Market. Soviet Dramatic Tool Steel Shift: Tungsten to Molybdenum. Apr. 25, 1973, p. 8.

concentrate that prevailed during the latter part of 1971 and throughout 1972, a major London-based dealer, Metal Traders Ltd., was forced to declare bankruptcy. Between 3,300 and 4,400 tons (about 3.4 to 4.5 million pounds tungsten) of Metal Traders' stock of tungsten concentrate were reportedly purchased by Climax Molybdenum Co. at £14.90 per metric ton unit (about $35.29 per short ton unit). About one-third to one-half of this material was believed to be of Chinese origin. In addition, some tungsten concentrate stocks were reportedly being held by banks until a better price could be obtained.

Zaire, Republic of.—In association with Philipp Brothers, Syndicat Minier de l'Etain (SYMETAIN) is a major wolframite producer located at Kalima and Punia, both in the Maniema district in Kivu.[32] Although official data for 1972 are not yet available, the SYMETAIN tungsten production was estimated to total about 66 tons, gross weight. Cobelmin-Zaire (COBELMIN), a subsidiary of Compagnie Belge d'Entreprises Minieres, recovers almost 60% of the country's tungsten production at two locations in Kivu Province. About one-quarter to one-third of the tungsten output in Zaire is produced in Kivu by KIVUMINES. A promising joint venture with Falconbridge of Canada Ltd. to exploit a wolframite deposit in northern Kivu was abandoned.

TECHNOLOGY

Studies were continued during the year by Bureau of Mines research metallurgists in an attempt to develop an economic process for recovering tungsten from the low-grade brine deposits of Searles Lake, Calif., which contain an estimated 135 million pounds of contained tungsten and could double the Nation's tungsten reserves.

An extensive evaluation of coal-cutter materials, conducted by scientists as part of the Bureau's health and safety program, indicated that tungsten carbide was among the least sparking and least incenditive of the cutting materials tested.[33]

As a result of research studies by Bureau of Mines engineers, methods were developed for the preparation of tungsten carbide from electrolytic solutions.[34]

The high volume of throwaway tool bits used in metal cutting operations prompted the investigation and development of methods to recover tungsten carbide by Bureau metallurgists.[35] Comparitive costs of tungsten carbide made from virgin tungsten powder and that recovered from scrap are roughly 4 to 1. Thus, the processing of scrap material is appealing both to carbide processors and to scrap metal dealers. In addition, it is further reported that the cost of processing scrap by this method is approximately one-fourth that of other reclamation methods.

Several studies conducted by research metallurgists at the Battelle Memorial Institute, Columbus, Ohio, developed economical freeze-drying processes for the production of ultrafine tungsten and tungsten carbide powders.[36] The fine cemented carbide powder produced by these techniques is expected to provide improved life for cutting tools.

A detailed review of chemical vapor deposition (CVD) methods used in tungsten processing techniques was sponsored by the

---

[32] U.S. Consulate, Lubumbashi, Rep of Zaire. Minerals Industry Report for Zaire. State Department Airgram A-13, May 30, 1973, 12 pp.

[33] Blickensderfer, R., J. E. Kelley, D. K. Deardorff, and M. I. Copeland. Testing of Coal Cutter Materials for Incendivity and Radiance of Sparks. BuMines RI 7713, 1972, 17 pp.

[34] Gomes, J. M., D. H. Baker, Jr., and K. Uchida (assigned to the U.S. Department of the Interior). A Method for the Electrolytic Preparation of Tungsten Carbide. U.S. Pat. 3,569,987, June 29, 1971.

[35] Barnard, P. G., A. G. Starliper, and H. Kenworthy. Process for Recycling Cemented Carbide Scrap. Manufacturing Eng. Trans. (Dearborn, Mich.), 1972, pp. 1–3.

Metal Progress. Vacuum Method Reclaims Refractory-Metal Carbide Scrap. V. 101, No. 5, May 1972, pp. 79–80.

[36] Battelle Columbus Labs. Freeze-Dry Preparation of Ceramic and Metallic Powders in the Materials Application Division. Columbus, Ohio, 1972, 13 pp.

Gelles, S. H., and F. K. Roehrig. Freeze-Dry Metals and Ceramics. J. Metals, v. 24, No. 6, June 1972, pp. 23–24.

Materials Application Division, Battelle Columbus Laboratories. Recent Activities in Powder Metallurgy Tungsten. Columbus, Ohio, Feb. 20, 1973, 7 pp.

Roehrig, F. K., and T. R. Wright. Carbide Synthesis by Freeze-Drying. J. Amer. Ceramic Soc., v. 55, No. 1, January 1972, p. 58.

———. Freeze-Drying: A Unique Approach to the Synthesis of Ultrafine Powders. J. Vac. Sci. Technol., v. 9, No. 6, November–December 1972, pp. 1368–1372.

Wessling, Jack. Freeze-Drying Process Studied for Ultrafine Metallic Powder. Am. Metal Market, v. 79, No. 134, July 12, 1972, p. 3.

Materials Science and Technology Division of the American Nuclear Society at the University of Utah in Salt Lake City.[37] Topics covered included fundamentals and techniques of CVD processes, composites, coatings, fibers, and powders; and application.

Continuing studies on vapor-deposited tungsten by National Aeronautics and Space Adminisration (NASA) metallurgists at the Lewis Research Center indicated that mechanical properties could be improved by the selective incorporation of various nonmetallic impurties.[38]

Additional studies of the mechanical behavior of CVD tungsten by University of Utah research metallurgists indicated a lower strength than that of standard powder metallurgy tungsten.[39] A way to fabricate complicated tungsten shapes was developed in which gaseous tungsten hexafluoride and hydrogen react at high temperatures to deposit pure tungsten on a copper pipe or mandrel.[40] When the copper is etched out, a pure tungsten pipe remains.

To eliminate the minute pits and flaws that lower the strength and increase the rate of rejects in cemented tungsten carbide products, Kennametal developed a process for producing exceptionally high-quality cemented tungsten carbide forms by simultaneous application of isostatic pressure of up to 20,000 pounds per square inch, and elevated temperature up to 2,750° F.[41]

In addition to using hot isostatic processing for bonding and pressing tungsten metal powder in variety of applications, several companies have reported using this process to manufacture tungsten carbides and tool steels.[42]

Consolidated tungsten metal was produced in good yields on a small scale by aluminothermic reduction of tungstic oxide with small amounts of calcium and sulfur to initiate the reaction at 450° C.[43] The aluminum in the consolidated tungsten, which initially contained 1,400 parts per million, 0.14%, was subsequently reduced to 30 parts per million by nonconsumable arc melting.

Submicroscopic gas bubbles trapped in doped tungsten filaments impart greater high-temperature strength to the metal by solid solution or dispersed second phase alloying.[44]

Tungsten alloys having excellent tensile strength and stress-rupture properties at 1,650° C and 1,920° C were prepared from sintered powder blends of tungsten and tungsten zirconium or zirconium nitride by high-impact (Dynapak) extrusion.[45] The strengthening was attributed to solid solution strengthening by zirconium and by submicron particles of zirconium dioxide.

A study of the development of submicroscopic porosity in several grades of doped tungsten wire was conducted in the temperature range between 3,000° and 3,350° C.[46] The extremely small submicroscopic pores inhibit recrystallization and permit development of the interlocking grain structure necessary for sag-resistant filaments.

A prototype device was developed for semiautomatic gas tungsten arc welding of small diameter tubing.[47] Because the torch nozzle is always centered over the weld joint where the arc is started, the arc length remains constant and arc initiation is easier since the tungsten is preset for the weld.

---

[37] Glaski, F. A. (ed.). Proceedings of the Third International Conference on Chemical Vapor Deposition. Am. Nuclear Society (Hinsdale, Ill.), 1972, 787 pp.

[38] National Aeronautics and Space Administration. Nonmetallic Impurities Improve Mechanical Properties of Vapor-Deposited Tungsten. NASA Technol. Brief B72-10454, August 1972, 1 pp.

[39] Chun, J. S., H. S. Shim, and J. G. Byrne. Mechanical Behavior of Chemical Vapor Deposited Tungsten. Met. Trans., v. 3, No. 12, December 1972, pp. 3093–3096.

[40] Chemical and Engineering News. Tungsten Shapes. V. 50, No. 27, July 3, 1972, p. 13.

[41] Kennametal Inc. Annual Report 1972, 19 pp.

[42] Boyer, C. B. Hot Isostatic Processing. Chem. Eng. Progress, v. 68, No. 5, May 1972, pp. 78–80. The complete 28-page manuscript may be obtained from AIChE Pub. Dept. 345 E. 47th St., New York.

[43] Belitskus, David. Aluminothermic Properties of Metals and Alloys. J. Metals, v. 24, No. 1, January 1972, p. 34.

[44] Dawson, Chester. Effect of a Temperature Gradient on Bubble Growth in Tungsten. Met. Trans., v. 3, No. 12, December 1972, pp. 3103–3107.

Sell, Heinz G. and George W. King. Bubble Strengthening a New Materials Concept. Res./Development, v. 23, No. 7, July 1972, pp. 18–21.

[45] Blickensderfer, R., M. I. Copeland, and W. L. O'Brien. Strengthening of Tungsten by Powder Metallurgical Internal Oxidation. Internat. J. of Powder Met., v. 8, No. 3, July 1972, pp. 145–155.

[46] Brett, J., and S. Friedman. High-Temperature Porosity in Tungsten. Met. Trans., v. 3, No. 4, April 1972, pp. 769–778.

[47] National Aeronautics and Space Administration and Small Business Administration. Spinarc Gas Tungsten Arc Torch Holder. Welding Technol., NASA SP-5918(02), 1973 p. 32. (Available from the National Technical Information Service, Springfield, Va.).

Uranium

By Walter C. Woodmansee [1]

The domestic uranium industry, from mining and milling through the nuclear fuel cycle to fuels reprocessing and waste management, made further progress toward establishing facilities adequate for an accelerating future demand. Exploration for uranium in the Western States was at a rate similar to that of 1971, but emphasis was on deeper drilling. Discoveries of significant new ore deposits were announced. There was little change in ore reserves, as determined by the Atomic Energy Commission (AEC), which placed increased emphasis on potential resources and on higher cost ores. Output of U_3O_8 concentrate increased; 20 mills, three of which started production during the year, were in operation. Two mills were closed and placed on a standby basis. Other sectors of the nuclear fuels industry continued development plans, which, however, were slowed by a soft market and environmental opposition. The AEC announced a new program of sharing enrichment technology with selected domestic companies and foreign nations.

Despite plans for an expanding domestic nuclear industry, the current market was one of continuing oversupply, excessive stocks, and soft prices. The AEC announced a new policy whereby it would not sell its U_3O_8 stockpile in the domestic or foreign market but would use it in preproducing enriched uranium for future sales, thereby avoiding direct competition with U_3O_8 producers in the domestic market. Although a uranium surplus prevailed, this situation was considered temporary; it was anticipated that low-cost U_3O_8 reserves and forward supply were not improving at

[1] Physical scientist, Division of Nonferrous Metals, Associate Directorate—Mineral Supply.

Table 1.—Salient uranium concentrate (U_3O_8) statistics

(Short tons U_3O_8 unless otherwise specified)

	1968	1969	1970	1971	1972
Production:					
Domestic:					
Mine: [1]					
Ore ---- thousand tons --	6,448	5,904	6,324	6,279	6,418
Content of ore	12,570	12,281	12,768	12,907	13,667
Average grade of ore -- percent U_3O_8 --	0.195	0.208	0.202	0.205	0.213
Recoverable [e] [2]	12,070	11,870	12,190	12,260	12,880
Value [e] [3] ---- thousands --	$182,698	$142,161	[r] $147,569	$151,996	$162,272
Mill, concentrate [4]	12,368	11,609	12,905	12,273	12,900
World [e] [5]	23,005	23,083	24,161	23,921	27,277
Deliveries of concentrate:					
Atomic Energy Commission:					
Quantity	7,337	6,184	2,520	--	--
Value ---- thousands --	$117,026	$72,336	$28,078	--	--
Price per pound	$8.00	$5.85	$5.59	--	--
Private industry [e]	5,000	6,200	9,300	12,800	11,600
Imports, concentrate	470	1,504	665	942	2,284
Reserves [6] ---- thousand tons --	161	204	246	273	273
Employment [7] ---- number of persons --	8,355	9,059	8,165	7,373	6,403

[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] Based on estimated recoverable content, average AEC price, and estimated average price for private sales for 1968–70; private sales only in 1971–72.
[4] Includes marketable concentrate from leaching operations.
[5] Non-Communist only.
[6] At $8 per pound U_3O_8.
[7] In exploration, mining, and milling, at yearend.

Sources: U.S. Atomic Energy Commission and Federal Bureau of Mines.

a satisfactory rate and that major new investments in exploration and development would be necessary to supply projected demand.

Orders for nuclear powerplants were higher compared with 1971, although delays continued in licensing and construction. The AEC made plans for expediting the licensing procedure by enlarging its regulatory staff and streamlining licensing procedures.[2] During 1972, seven nuclear powerplants were licensed for full-power operation, two for partial power operation, and eight for construction starts.

Nuclear power development plans were prevalent worldwide, particularly (outside the United States) in Western Europe, Japan, and the U.S.S.R. Also, many developing nations had programs for nuclear power. New uranium mines in Australia, Niger, and the Territory of South-West Africa were under development to supply a growing number of international contracts for U_3O_8.

Exploration.—Footage in exploration and development drilling, reported to the AEC by 84 companies, was at a rate similar to that of 1971. The trend continued toward deeper exploration drilling. About 32% of this activity was in areas more than 50 miles from existing production centers. Principal exploration was in Wyoming (43%), New Mexico (23%), and Texas (22%). Salient data for 1972 were as follows: [3]

Land held, yearend	million acres	5.6
Expenditures:		
Land acquisition	million dollars	4.7
Drilling (surface):		
Exploration	do	15.4
Development	do	2.7
Other	do	9.6
Total		32.4

The industry held 17.7 million acres at yearend 1972 (19 million acres in 1971) and planned drilling programs of 18.5 million feet ($35.5 million) in 1973 and 20.3 million feet ($38.2 million) in 1974.

Table 2.—Surface drilling for uranium

	1971	1972
Type of drilling: [1]		
Exploration ... million feet	11,400	11,815
Development ... do	4,052	3,609
Total	15,452	15,424
Number of holes:		
Exploration	28,416	26,909
Development	10,440	9,706
Total	38,856	36,615
Average depth per hole:		
Exploration ... feet	401	439
Development ... do	388	371

[1] Does not include claim validation drilling or underground long-hole and diamond drilling.

Source: U.S. Atomic Energy Commission.

Table 3.—Domestic uranium resources in 1972 [1]

(Thousand tons U_3O_8)

	$8 [2]	$10 [2]	$15 [2]
Reserve	273	337	520
Potential	450	700	1,000

[1] At yearend.
[2] Cutoff cost; higher cost resource includes that at lower cost.

Source: U.S. Atomic Energy Commission.

Reported significant uranium discoveries during the year included those of Western Nuclear Corp. in the Ruby Wells area, McKinley County, N. Mex., and Atlas Corp. in the Sage Plains, near Moab, Utah.

A joint venture involving Ranchers Exploration and Development Corp., Occidental Minerals Corp., and Frontier Mining Corp. planned a 2-year exploration and development program in northwest New Mexico.

Reserves and Resources.—Domestic uranium reserves at $8 per pound U_3O_8 remained unchanged at yearend 1972, additions being approximately equal to depletion by production during the year. Reserves at $10 per pound U_3O_8 increased by

[2] U.S. Atomic Energy Commission. 1972 Annual Report to Congress, Regulatory Activities. January 1973, 54 pp.
[3] U.S. Atomic Energy Commission, Grand Junction, Colo. Uranium Exploration Expenditures in 1972 and Plans for 1973–74. GJO–103(73), May 1973, 8 pp.

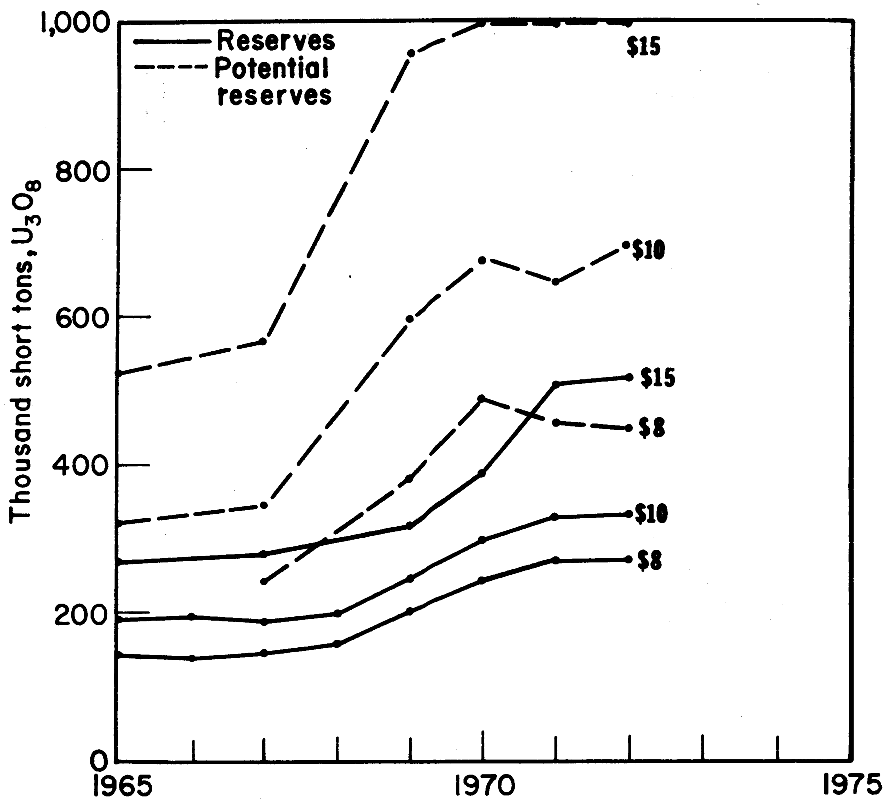

Figure 1.—Domestic uranium resources.

4,000 tons U_3O_8.[4] There were 781 reserve properties in the $8-per-pound category, of which 49% were in New Mexico and 36% in Wyoming.

In 1972, the AEC extended potential resources (those in unexplored areas, mainly in and near known deposits and districts) to include the $15-per-pound cutoff. Reserves and potential resources in this category totaled 1.5 million tons U_3O_8.[5]

DOMESTIC PRODUCTION

Mine.—Uranium mine output showed a significant increase in terms of gross weight of ore, recoverable U_3O_8, and average grade of ore. New Mexico and Wyoming continued as the dominant producing States, accounting for 75% of total output. There were 141 underground (40% of output) and 37 open pit mines (58% of output) producing during the year; in addition to these normal mining operations, 196 tons of U_3O_8 was produced at 12 miscellaneous operations (leaching, mine water, raffinate). Development was underway at a number of properties, particularly in New Mexico, Wyoming, and Utah.

Mill.—Mill production increased by more than 600 tons U_3O_8. Three new mills went onstream during the year, and two mills ceased operations and were placed on standby. Total existing capacity was almost 32,000 tons of ore throughput per day and 19,000 tons U_3O_8 per year. The mills were worked at 68% of capacity.

Nuclear Fuel Materials.—Development of private commercial facilities continued for production of uranium hexafluoride (UF_6), nuclear fuels and fabrication in fuel assemblages, spent fuel reprocessing,

---

[4] U.S. Atomic Energy Commission, Grand Junction, Colo. Statistical Data of the Uranium Industry. GJO-100(73), Jan. 1, 1973, pp. 12–17.

[5] U.S. Atomic Energy Commission, Grand Junction, Colo. Potential Uranium Resources of the Western United States. GJO-104(73), May 1973, 7 pp.

and depleted uranium. Approximately 21 companies with 30 plants were active in the nuclear fuels industry or planned new installations. Uranium enrichment was the only service not provided by private industry, but several proposals for enrichment facilities were made to the AEC.

Uranium Hexafluoride.—The UF_6 plant of Allied Chemical Corp. at Metropolis, Ill., was closed down much of the year and, when in operation, worked at only partial capacity. Kerr-McGee Corp. operated its UF_6 plant at Sequoyah, Okla., at 60% of capacity during the year. This idle capacity reflected a shortage of orders for U_3O_8-UF_6 conversion.

The AEC planned to process its U_3O_8 stockpile to UF_6 at its own facilities.

Enriched Uranium.—During 1972, the AEC received revenues of $138 million for

Table 4.—Recoverable U_3O_8 mine production, by State [1]

(Thousand pounds U_3O_8 and thousand dollars)

State	1970		1971		1972	
	Quantity	Value e	Quantity	Value e	Quantity	Value e
Colorado	2,727	15,832	2,536	15,725	1,877	11,825
New Mexico	11,574	69,970	10,567	65,517	10,808	68,091
Utah	1,635	10,023	1,445	8,959	1,496	9,425
Wyoming	6,346	38,768	6,986	43,311	8,544	53,827
Other [2]	r 2,094	r 12,976	2,981	18,484	3,033	19,104
Total	r 24,376	r 147,569	r 24,515	r 151,996	25,758	162,272

e Estimated. r Revised.

[1] Based on mill recovery factors and estimated average market price per pound U_3O_8. Does not include uranium recoverable in miscellaneous operations (leach, mine waters, and raffinate).

[2] Alaska, South Dakota, Texas, and Washington; combined to avoid disclosing individual company confidential data.

Table 5.—Major new uranium mining developments in 1972

State	Company	Property and location	Activities
New Mexico	Kerr-McGee Corp	Sec. 35 mine, Church Rock, near Gallup.	Sinking 14-foot, 3-compartment shaft; shaft at 1,550 feet in November; plan 1,850 feet. Production scheduled 1975.
Do	United Nuclear Corp., Inc.	Church Rock, near Gallup.	Underground mine development; production early in 1973. Reserves 22 million pounds U_3O_8.
Do	Ranchers Exploration and Development Corp.	Sec. 7 mine, Ambrosia district.	Plan shaft sinking to 1,350 feet in 1973; joint venture with Houston Natural Gas Corp. Sales contract for U_3O_8 concluded with Gulf Oil Corp.
Do	Reserve Oil and Minerals Corp.	Evans Ranch, 45 miles west of Albuquerque.	Joint venture with Sohio Petroleum Co.; reserves of 17 million pounds U_3O_8; preliminary study made for mine and mill.
Texas	Continental Oil Co.—Pioneer Nuclear, Inc.	Falls City, Texas	Mine in full production at 600,000 tons of ore yearly; 2 to 3 pounds U_3O_8 per ton.
Utah	Rio Algom Mines, Ltd	Lisbon Valley district	Production started June; 18-foot shaft sunk to 2,600 feet.
Do	Atlas Corp	Green River district, 12 miles west of Green River.	Contract let for shaft sinking to 640 feet. Production scheduled 1973.
Wyoming	Federal Resources Corp. —American Nuclear Corp.	Gas Hill district	12-year lease to Carolina Light and Power Co. for 12 million pounds U_3O_8.
Do	United Nuclear Corp., Inc.	Morton Ranch, Boner Ranch, southern Powder River Basin.	Acquired remaining 50% interest from Duval Corp. Reserves estimated at 8 million pounds U_3O_8.
Do	Kerr-McGee Corp., Getty Oil Co., Skelly Oil Co. (KGS).	Shirley Basin	Phasing out operations; poor market. Petrotomics mill to continue operating on toll basis.
Do	Tennessee Valley Authority, American Nuclear Corp.	Laramie area	TVA acquired 20% mineral interest for $2 million; options for up to 50% interest.
Do	Exxon Co	Highland mine, Powder River Basin.	New mine at 2,800 tons ore per day; plan open pit development at other locations.
Do	Kerr-McGee Corp	Powder River Basin	Underground mine development; production scheduled 1976.

Table 6.—U.S. uranium mill statistics in 1972

(Short tons U_3O_8 unless otherwise specified)

Operating mills number	20
Average daily milling rate tons of ore	17,500
Mill receipts, content of ore	13,667
Mill feed:	
Content of ore	13,592
Other [1]	220
Total	13,812
Recovery rate percent	93
Production	12,900
Shipments	11,299
Stocks:	
Content of ore, Jan. 1, 1972	196
Content of ore, Dec. 31, 1972	271
Concentrate, Jan. 1, 1972	2,100
Concentrate, Dec. 31, 1972	3,701
In process:	
Concentrate, Jan. 1, 1972	467
Concentrate, Dec. 31, 1972	469

[1] Concentrate from leaching operations, mine waters, refinery residues, recycled tailings, and cleanup.

Source: U.S. Atomic Energy Commission.

Table 7.—U.S. uranium milling companies and plants in 1972

Company	Plant location	Capacity (tons of ore per day)
The Anaconda Company	Bluewater, N. Mex	3,000
Atlas Corp	Moab, Utah	1,500
Continental Oil Co.—Pioneer Nuclear, Inc	Falls City, Tex	[1] 1,750
Cotter Corp	Canon City, Colo	450
Dawn Mining Co	Ford, Wash	500
Exxon Co	Powder River Basin, Wyo	[1] 2,000
Federal Resources Corp.—American Nuclear Corp	Gas Hills, Wyo	950
Kerr-McGee Corp	Grants, N. Mex	7,000
Mines Development, Inc	Edgemont, S. Dak.[2]	650
Petrotomics Co	Shirley Basin, Wyo	1,500
Rio Algom Mines, Ltd	La Sal, Utah	[1] 500
Susquehanna-Western Inc	Falls City, Tex	1,000
Do	Ray Point, Tex	1,000
Union Carbide Corp	Uravan, Colo	} 2,000
Do	Rifle, Colo.[2]	
Do	Natrona County, Wyo	1,000
United Nuclear Corp. Inc.—Homestake Mining Co	Grants, N. Mex	3,500
Utah International Inc	Gas Hills, Wyo	1,200
Do	Shirley Basin, Wyo	1,200
Western Nuclear, Inc	Jeffrey City, Wyo	1,200
Total		31,900

[1] Initial production in 1972.
[2] Mill on standby at yearend.

Source: U.S. Atomic Energy Commission.

4.3 million Separative Work Units (SWU)[6] of enriched uranium services to domestic (2.4 million SWU) and foreign (1.9 million SWU) customers. Since toll enrichment services began in 1969, cumulative revenues have totaled $523 million. New contracts were negotiated with 16 domestic and 23 foreign customers during the year and, at yearend, 46 domestic and 46 foreign contracts were active, providing for 290 million SWU, which (at $32 per SWU) were valued at $9.3 billion. In addition, during 1972 the AEC received $9 million for in-situ enrichment services, a procedure whereby AEC-owned enriched uranium held under lease may be converted to private ownership.[7]

The AEC's three gaseous-diffusion enrichment plants—at Oak Ridge, Tenn., Paducah, Ky., and Portsmouth, Ohio—were

[6] Measure of work expended in separating a quantity of uranium (in kilograms) at a given assay into two fractions—ore enriched in U_{235} to a specified grade and the other deficient in U_{235} to a specified tailings grade.

[7] U.S. Atomic Energy Commission. 1972 Annual Report to Congress. Operating and Developmental Functions. Jan. 31, 1973, p. 36.

operated at about 40% of capacity (17.2 million SWU), which was sufficient for domestic and foreign orders. It was anticipated that additional enrichment capacity will be needed in the early 1980's and plans were underway to expand annual capacity to 26.5 million SWU and preproduce enriched uranium using the AEC's U_3O_8 stockpile at a higher tails assay. According to plans, the transaction tails assay would be 0.2% U_{235}, whereas the actual operating assay would be 0.275% U_{235} or 0.30% U_{235}. More feedstock would be processed, using the stockpile material, and fewer SWU's would be required, resulting in reduced operating costs. The deferment of the need for new capacity would permit the use of any newly developed technology and may provide greater opportunities for private industry participation in enrichment operations.[8] Preproduced enriched uranium was expected to fill orders in the late 1970's.

Following AEC announcements providing for possible future access to enrichment technology and encouraging private participation in enrichment operations, a number of proposals were made to the AEC. Early in the year, Reynolds Metals Co. planned to create a consortium for a $2.2 billion, gaseous-diffusion operation for 8.75 million SWU per year, located near Buffalo, Wyo., where the company controls large coal and water resources.[9] A group involving Bechtel Corp., Union Carbide Corp., and Westinghouse Electric Corp. was considering the feasibility of a $1.5 billion facility. In another proposal, Electro-Nucleonics Inc. would lead four other U.S. companies in an engineering development and management group for enrichment by the gas-centrifuge method.[10]

Fabrication.—Westinghouse Electric Corp. announced plans for a $30 million, mixed oxide (uranium-plutonium) fuel plant, at capacity of several hundred tons per year, near Anderson, S.C. The fuels will be made from recycled fissionable material. Construction was scheduled to start in 1974.[11]

Reprocessing.—In July, Allied Gulf Nuclear Services, Inc., submitted a license application and environmental report for new facilities, adjacent to its reprocessing plant at Barnwell, S.C., for conversion of uranyl nitrate to UF_6.

General Electric Co. planned reprocessing operations after engineering tests are made and an operating license is received at its Midwest Fuel Recovery Plant, near Morris, Ill. The first spent fuel arrived at the plant in January. Later in the year, the AEC issued a notice of intent to grant license.

The fuel fabricating and reprocessing plant of Nuclear Fuel Services, Inc. (NFS), at West Valley, N.Y., was shut down most of the year. NFS sought an AEC permit for expansion and equipment modification. The company planned to triple the existing 1-ton-per-day reprocessing capacity.

Scrap.—According to the AEC, 900 kilograms of Pu_{239}, 6.3 kilograms of Pu_{238}, and 4,000 kilograms of enriched uranium, valued at $32 million, $3.2 million, and $28.5 million, respectively, were recovered from AEC and commercial scrap during 1972. A centralized scrap management system was established to coordinate AEC efforts to recover valuable constituents from growing stocks of scrap materials.

Waste Management.—At the AEC's facilities at Hanford, Wash., and Savannah River, Aiken, S.C., new storage tanks were under construction for AEC-generated radioactive waste materials. Liquid wastes were evaporated to salt crystals for tank storage. Long-lived, heat-generating cesium-137 and strontium-90 were separated from other wastes and stored as liquid concentrates. A total of 135,000 gallons of waste was converted to 2,410 cubic feet of granular calcine at the AEC's Waste Calcining Facility, National Reactor Testing Station, Idaho, during the year. These materials were stored in stainless steel bins in underground concrete vaults.

The AEC has accumulated 85 million gallons of high-level wastes in underground tanks since inception of its storage program. Research and development continued on ultimate disposal methods and procedures.[12]

[8] Atomic Industrial Forum. New Master Policy for Fuel Supply. Nuclear Ind., v. 19, No. 3, March 1972, pp. 11–18.
[9] Atomic Industrial Forum. Reynolds Gives AEC First Private Enrichment Proposal. Nuclear Ind., v. 19, No. 4, April 1972, pp. 13–14.
[10] The Mining Record. Consortium May Build Plant to Enrich Uranium by Gas Centrifuge. V. 83, No. 50, Dec. 13, 1972, p. 5.
[11] Atomic Industrial Forum. Westinghouse to Build Commercial-Scale Mixed-Oxide Fuel Plant. Nuclear Ind., v. 19, Nos. 11–12, pt. 2, November–December 1972, p. 36.
[12] Pages 61–64 of work cited in footnote 7.

A number of disposal methods were under consideration for long-term storage of high-level radioactive wastes at great depth in geological formations, which would reduce the burden of continual surveillance and control. This included storage in salt beds in Kansas; potash or limestone beds in New Mexico; basalt at Hanford, Wash.; deep trenches in the ocean floor; and deltaic areas, where actively accumulating sediments would increase the burial depth relatively rapidly. Other considerations were conversion of the trans-uranic radioisotopes to short-lived types and transport of wastes by rocket to the sun. The AEC, through the National Aeronautics and Space Agency, sought estimated costs for radioactive waste disposal in space, which, however, would depend on development of the space shuttle.

The AEC planned a dual approach—engineered surface storage (ESS) and underground storage—for high-level wastes from commercial reactors. In ESS, the wastes

Table 8.—Principal nuclear fuel processing and production facilities in 1972

Company	Location	Product or service
Allied Gulf Nuclear Services, Inc.	Barnwell, S.C	Reprocessing;[1] conversion enriched U to UF_6.[1]
Allied Chemical Corp	Metropolis, Ill	UF_6.
Atomics International Division, North American Rockwell Corp.	Canoga Park, Calif	Fabrication of UO_2, carbide, special, and Pu fuels; depleted U metal; Pu scrap.[1]
Babcock and Wilcox Co	Lynchburg, Va	UO_2;[1] UO_2 pellets;[1] fabrication of UO_2 and Pu fuels; U [1] and Pu [1] scrap.
Combustion Engineering Co	Windsor, Conn	UO_2;[1] UO_2 pellets; fabrication of UO_2 and Pu [1] fuels.
Exxon Nuclear Co	Richland, Wash	UO_2; UO_2 pellets; fabrication of UO_2 and Pu fuels; U [1] and Pu scrap.[1]
General Electric Co	Morris, Ill	Reprocessing; conversion enriched U to UF_6.
Do	San Jose and Vallecitos, Calif	Fabrication of Pu fuels; U and Pu [1] scrap.
Do	Wilmington, N.C	UO_2; UO_2 pellets; fabrication of UO_2 fuels; U scrap.
Goodyear Atomic Corp.[2]	Portsmouth, Ohio	Enriched UF_6.
Gulf General Atomic Co	San Diego, Calif	Fabrication of carbide, special, and U_{233}[1] fuels; U scrap.
Gulf United Nuclear Fuels Corp.	Elmsford and Pawling, N.Y	Fabrication of carbide and Pu fuels; Pu scrap.[1]
Do	Hematite, Mo	UO_2; UO_2 pellets; fabrication of carbide fuels; depleted U compounds.
Do	New Haven, Conn	Fabrication of UO_2 and special fuels; depleted U metal.
Kerr-McGee Corp	Cimarron, Okla	UO_2; UO_2 pellets; fabrication of UO_2, carbide, special, and Pu fuels; depleted U metals and compounds; U and Pu scrap.
Do	Sequoyah, Okla	UF_6.
NL Industries	Albany, N.Y	Fabrication of special fuels; depleted U metal.
Nuclear Chemicals and Metals Corp.	Huntsville, Tenn	UO_2;[1] fabrication of carbide fuels; depleted U compounds; U scrap.[1]
Nuclear Fuel Services, Inc	Erwin, Tenn	UO_2; UO_2 pellets; fabrication of UO_2, carbide, U_{233}, and Pu fuels; depleted U metal and compounds; U and Pu scrap.
Do	West Valley, N.Y	Fabrication of UO_2 and Pu fuels;[1] reprocessing; enriched U to UF_6.[1]
Nuclear Materials and Equipment Corp.	Apollo, Pa	UO_2; UO_2 pellets; fabrication of UO_2, carbide, and special fuels; depleted U compounds; U scrap; conversion enriched U to UF_6.
Do	Leechburg, Pa	UO_2; UO_2 pellets; fabrication of UO_2, carbide, special, U_{233}, and Pu fuels; depleted U metal; Pu scrap.
Nuclear Metals Div., Whittaker Corp.	West Concord, Mass	Fabrication of special fuels.
Tennessee Nuclear Specialties, Inc.	Jonesboro, Tenn	UO_2; depleted U metal; U scrap.
Texas Instruments, Inc	Attleboro, Mass	Fabrication of special fuels.
Union Carbide Corp.[2]	Oak Ridge, Tenn	Enriched UF_6.
Do [2]	Paducah, Ky	Do.
United Nuclear Corp. Inc	Wood River Junction, R.I	U scrap.
Westinghouse Electric Corp	Cheswick, Pa	UO_2 pellets; fabrication of UO_2, 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 UO_2 and Pu fuels.

[1] Under construction or planned.
[2] Contractor for Atomic Energy Commission.

Source: U.S. Atomic Energy Commission.

would be reduced by solidification processes and stored in sealed canisters by reprocessors for a few years and then delivered to AEC facilities. The AEC planned to design and build an ESS facility for high-level wastes by 1979 or 1980. This installation would be designed so that wastes could be moved to underground storage if desired at a later date. A nationwide plan for waste disposal was under development by contract with Battelle-Northwest, Richland, Wash.

CONSUMPTION AND USES

Demand for U_3O_8 for commercial nuclear fuel use was gradually escalating as new orders were announced for nuclear power reactors. According to the AEC, nine units (13,870 megawatts) at eight locations were licensed for operation during the year. At yearend, the status of commercial reactor development in the United States was as follows:

Number of plants	Capacity (megawatts)	Status
29	14,683	Operable.
55	47,775	Under construction.
76	80,000	Under contract (reactors ordered).
Total 160	142,458	

The historical record for commercial orders for nuclear powerplants is as follows:

Year	Number of plants	Capacity (megawatts)
1965 [1]	20	8,456
1966	20	16,345
1967	30	25,427
1968	14	12,872
1969	7	7,203
1970	14	14,305
1971	20	19,921
1972	35	37,929
Total	160	142,458

[1] Excludes small prototype plants no longer in operation.

The trend continued toward larger capacity units, and, in September, a contract was signed for the first offshore-sited nuclear power station, along the New Jersey coast.[13]

Table 9.—Current and projected domestic demand for U_3O_8 [1]

(Short tons)

Year	Low	High	Probable	
			Annual	Cumulative
1972	XX	XX	7,600	7,600
1973	8,400	11,300	10,000	17,600
1974	11,700	15,600	13,800	31,400
1975	15,100	20,400	18,200	49,600
1980	36,600	44,000	38,400	197,300
1985	59,900	85,500	71,500	481,700
2000	110,000	192,000	153,600	NA

NA Not available. XX Not applicable.
[1] 0.30% U_{235} tails assay; Pu recycle start 1977.

Source: U.S. Atomic Energy Commission.

Table 10.—Current and projected domestic nuclear power capacity

Year	Estimated cumulative capacity (megawatts)		
	Low	High	Probable
1972	XX	XX	14,683
1973	21,700	31,200	28,900
1974	35,000	49,000	42,300
1975	52,100	56,900	54,200
1980	127,000	144,000	131,600
1985	256,000	332,000	280,000
2000	825,000	1,500,000	1,200,000

XX Not applicable.

Source: U.S. Atomic Energy Commission.

The fast breeder reactor, introduced as early as 1986 in AEC contingency planning, was expected to have an impact on demand for U_3O_8 before the end of the century.[14] The liquid-metal fast breeder reactor (LMFBR), given priority in AEC breeder reactor planning, theoretically can

[13] Atomic Industrial Forum. Jersey's Public Service Electric and Gas Co. Goes to Sea, Orders $1 Billion Offshore Plant. Nuclear Ind., v. 19, No. 9, September 1972, pp. 15–17.

[14] U.S. Atomic Energy Commission, Office of Planning and Analysis, Forecasting Branch. Nuclear Power 1973–2000. WASH–1139(72), Dec. 1, 1972, 42 pp.

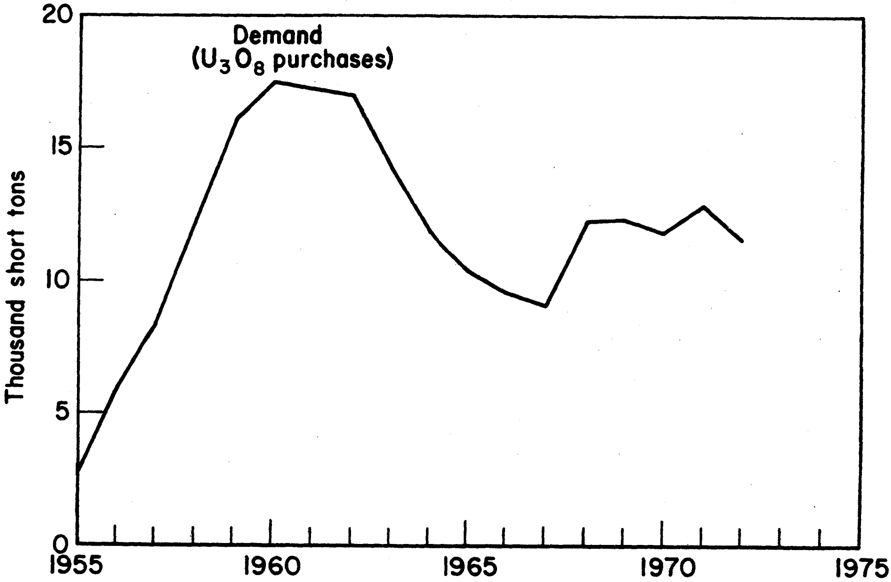

Figure 2.—Domestic uranium demand.

produce 4 pounds of plutonium while 3 pounds are consumed as fuel. The nation's first demonstration LMFBR will be constructed in the Tennessee Valley Authority transmission network, near Oak Ridge, Tenn., and will test the technological and economic feasibility of the fast breeder concept.[15]

Table 11.—Current and projected domestic commercial uranium delivery commitments

(Short tons U_3O_8)

Year	Commitments [1] Annual	Cumulative
1972	11,600	[2] 43,500
1973	12,300	55,800
1974	12,500	68,300
1975	15,800	84,100
1976	7,600	91,700
1977	7,600	99,300
1978	6,400	105,700
1979	7,100	112,800
1980	5,100	117,900

[1] In the post-1980 period, through 1992, an additional 11,900 tons have been committed. In addition, 6,900 tons have been committed to foreign buyers, of which 4,800 tons were delivered prior to yearend 1972.

[2] Pre-1972 deliveries were 31,900 tons.

Source: U.S. Atomic Energy Commission.

An AEC uranium-marketing survey of 57 utility companies, 5 reactor manufacturers, and 19 uranium producers indicated an increase of 15,700 tons U_3O_8 in commitments during 1972.[16] A total of 11,600 tons U_3O_8 was delivered to the domestic market during the year. The status on total commitments, including foreign, was as follows:

	U_3O_8 (tons)
Deliveries and forward commitments, Jan. 1, 1972	114,100
Deliveries and forward commitments, Jan. 1, 1973	129,800
Deliveries, through Jan. 1, 1973	43,500
Forward commitments, Jan. 1, 1973	86,300

The survey also revealed that arrangements had been made for only 61% of

[15] American Nuclear Society. Nuclear News Briefs. Nuclear News, v. 15, No. 4, April 1972, p. 17.

[16] U.S. Atomic Energy Commission, Office of Assistant Director for Raw Materials, Division of Production and Materials Management. Survey of United States Uranium Marketing Activity. WASH-1196(73), April 1973, 15 pp. and attachments.

Table 12.—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	13	14	15
Primary producers	34	37	29	28	18	17	11	8	7	3	2	2	2	2	1	1
Reactor manufacturers	27	18	19	14	11	4	4	3	2	1	1	--	--	--	--	--
Total	61	55	48	42	29	21	15	11	9	4	3	2	2	2	1	1

[1] As of yearend 1972. Includes reactors operating, under construction, and scheduled, totaling 141,000 megawatts. Does not include leases from AEC which are small, comprising less than 0.5% for first cores and for refueling through seventh reload, when they are scheduled to terminate.
[2] Refueling estimated on annual basis.

Source: U.S. Atomic Energy Commission.

Table 13.—Current and projected domestic demand for separative work [1]

(Thousand SWU per year)

Year	Low	High	Probable
1972	XX	XX	2,300
1973	2,400	3,700	3,500
1974	4,200	5,200	4,300
1975	5,200	7,500	6,800
1980	14,700	17,400	15,300
1985	25,600	35,800	30,000
2000	53,500	92,300	74,300

XX Not applicable.
[1] Domestic orders only; 0.30% U_{235} tails assay; Pu recycle start in 1977.

Source: U.S. Atomic Energy Commission.

first-core fuels and progressively less for annual reloads.

Demand for separative work and enriched uranium also was expected to gradually accelerate. An Atomic Industrial Forum study concluded that world demand for enriched uranium will exceed cumulative supply by 1981, 8,700 SWU (about half the existing AEC capacity) will be needed to avoid a serious shortfall at that time, and a further increment at the same capacity will be needed in 1982.[17]

Ultrapure depleted uranium has potential use as a catalyst in the hydrocracking of shale oil. The addition of 10% depleted uranium to alumina and cobalt molybdates increased the hydrocracking activity of these catalysts, permitting lower operating temperatures and increased gasoline yields.[18]

Table 14.—Current and projected domestic demand for UF_6 enrichment plant feed [1]

(Metric ton units per year)

Year	Low	High	Probable
1972	XX	XX	4,700
1973	4,900	7,600	7,000
1974	8,100	9,800	8,300
1975	9,900	14,200	13,000
1980	25,800	30,500	26,700
1985	42,900	60,800	50,700
2000	84,500	146,500	117,500

XX Not applicable.
[1] Domestic orders only; 0.30% U_{235} tails assay; Pu recycle start in 1977.

Source: U.S. Atomic Energy Commission.

STOCKS

The AEC reported private U_3O_8 concentrate inventories as follows, in tons U_3O_8, at the beginning of the year:

	1972	1973
In ore at mills	196	271
In process at mills	467	469
Inventory at mills	2,100	3,701
Inventory held by utility companies and reactor manufacturers (includes UF_6)	8,600	14,400
Total	11,363	18,841

In addition, the utility and reactor companies held inventories of enriched uranium.

Proposals for U_3O_8 sales from the AEC stockpile, announced late in 1971, were rescinded early in 1972 when it appeared that direct Government entry in the domestic U_3O_8 market might cause disruptions during a period of oversupply and depressed prices and would also tend to discourage private investment in uranium exploration. This stockpile, containing an estimated 50,000 tons U_3O_8, was accumulated during the 1960's as a result of cutbacks in AEC demand for fissionable material and before

[17] Atomic Industrial Forum. The Time For Action Is Now. Nuclear Ind., v. 19, No. 10, October 1972, pp. 3–13.
[18] Chemical and Engineering News. New Use for Depleted Uranium. V. 50, No. 16, Apr. 17, 1972, p. 23.

development of a private industrial market for uranium in power reactor fuels.

The AEC planned to preproduce enriched uranium for future sales by operating its gaseous-diffusion enrichment plants at higher tails assay (0.275–0.3% U_{235}) while continuing the existing schedules for enrichment services, the additional feed material coming from the stockpile.[19] This program would avoid direct competition for U_3O_8 sales with the domestic uranium mining and milling companies, put the existing stockpile to productive use, and extend the period before additional enrichment capacity will be needed.

PRICES

A downward price trend for U_3O_8, which started in 1968, persisted during 1972 but appeared to have bottomed out and started a slight recovery. Available published data indicated that U_3O_8 prices were in the \$6–\$6.25-per-pound-U_3O_8 range for spot sales with immediate delivery and for starting prices in multiyear sales contracts with price escalation. The price approached \$8 per pound U_3O_8 in contracts extended post-1976.

According to the Nuclear Exchange Corp., foreign prices were about 20% lower than U.S. prices.[20] Foreign sales were often at \$5 to \$6 per pound U_3O_8; some sales were at prices below \$5 per pound U_3O_8.

The Commission of the European Communities (EC) reported an upward trend in prices and an agreement on future prices among its member countries. Early in the year, U_3O_8 prices in contracts covering 1972–78 were in the range of \$4.50 to \$6.60 per pound; later in the year, bids for the 1974–78 period ranged from \$5.95 to \$7.80 per pound. With these higher future prices, U.S. producers were in a position to submit competitive bids to consumers in the Community.[21]

The AEC announced a proposed price increase, effective August 14, 1973, in uranium toll enrichment services from \$32 to \$38.50 per SWU because of increased actual and projected costs, primarily for electric power. The AEC also intended to offer a reduced charge, \$36 per SWU, for services under proposed new long-term fixed-commitment contracts, which would permit better planning for enrichment services. Unit charges were scheduled to automatically increase 1% per 6 months, starting in January 1974, in order to partially offset future anticipated cost increases.

FOREIGN TRADE

Imports of U_3O_8 and other uranium compounds (mainly UF_6 and enriched UF_6) increased substantially during 1972. These materials were delivered to commercial plants for U_3O_8–UF_6 conversion and to the AEC for UF_6 enrichment services for foreign customers. Pursuant to section 161V, Atomic Energy Act of 1954, as amended, foreign uranium source materials cannot be imported for domestic consumption. The AEC announced plans to reconsider the lifting of this embargo within 2 years and possible repeal by 1978. The United States continued as a major world supplier of various radioactive and special nuclear materials.

[19] Pages 34–36 of work cited in footnote 7.
[20] Mommsen, J. The Market for Uranium and Plutonium. Nuclear News, v. 15, No. 5, May 1972, pp. 39–41.
[21] Commission of the European Communities. Report on the Activity of the Euratom Supply Agency for the Year 1972. Euratom Supply Agency, Brussels, Belgium, Jan. 10, 1973, 13 pp.

Table 15.—Foreign trade in uranium, uranium-bearing materials, and other nuclear materials, by principal country

Product	1971 Quantity	1971 Value	1972 Quantity	1972 Value	Principal sources and destinations, 1972
EXPORTS					
Uranium:					
Ore and concentrate, U_3O_8 content pounds	89,285	$751,375	151,590	$626,843	All to Canada.
Compounds do	6,021,148	38,498,069	6,714,148	46,614,501	Canada 4,170,598; United Kingdom 2,521,235; Brazil 10,787; West Germany 8,449.
Metal including alloys [1] do	65,592	r 943,930	16,624	291,048	Italy 14,119; Canada 1,695.
Isotopes (stable) and their compounds	NA	28,561,798	NA	19,053,518	Argentina $14,854,484; Canada $3,100,951; West Germany $306,640; United Kingdom $199,277; Australia $189,699.
Radioactive materials: Radioisotopes, elements, and compounds [2] thousand curies	23,119,896	6,719,185	10,409,327	8,370,247	Canada 6,289,841; Japan 1,200,930; West Germany 600,439; Belgium-Luxembourg 541,714; Switzerland 345,360; Canary Islands 305,621.
Special nuclear materials [3]	NA	160,332,329	NA	103,789,521	West Germany $66,163,170; Japan $17,153,155; United Kingdom $7,262,980; India $4,002,654; Sweden $2,626,814; Belgium-Luxembourg $2,166,212.
IMPORTS					
Uranium:					
Oxide (U_3O_8) pounds	1,883,358	11,759,589	4,568,033	30,224,696	Canada 3,767,020; Republic of South Africa 801,013.
Other compounds do	7,966,452	55,304,176	10,731,091	74,922,171	United Kingdom 4,531,895; Canada 4,180,373; France 2,018,471.
Isotopes (stable) and their compounds	NA	436,244	NA	435,155	Canada $235,772; United Kingdom $79,632; Israel $37,984; West Germany $27,127; France $25,647.
Radioactive materials: Radioisotopes, elements and compounds [2] thousand curies	6,142,747	5,670,975	22,622,605	3,009,633	Canada 18,718,653; Switzerland 1,959,000; United Kingdom 1,205,561; Belgium-Luxembourg 400,915.

r Revised. NA Not available.
[1] Includes thorium.
[2] Includes carbon-14 and cobalt-60.
[3] Includes plutonium, uranium-233, uranium-235, and enriched uranium.

WORLD REVIEW

Exploration for uranium in foreign countries continued at a slow pace for the most part, except in Australia, where activity was spurred by recent discoveries. Important new mines were under development in Australia, Canada, and the Territory of South-West Africa.

Foreign countries with major uranium resources—Australia, Canada, France, and Republic of South Africa—sent representatives to Paris in February to consider the problems of oversupply and depressed prices for uranium in world markets. At a second meeting in March, also in Paris, the group called for rationalization of production or other marketing arrangements. At a third meeting, in Johannesburg, South Africa, in June, an attempt was

Table 16.—Uranium oxide (U_3O_8) concentrate: World production, by country

(Short tons)

Country [1]	1970	1971	1972 p
Argentina	50	54	e 110
Australia	e 330	(2)	--
Canada	4,104	4,107	4,898
France	3 1,944	3 1,935	1,921
Gabon	416	601	577
Niger	42	474	956
Portugal e	105	105	105
South Africa, Republic of	4,119	4,189	5,589
Spain	r 66	103	141
Sweden e	80	80	80
United States	12,905	12,273	12,900
Total	24,161	23,921	27,277

e Estimate. p Preliminary. r Revised.

[1] In addition to the countries listed, Brazil, Czechoslovakia, Finland, East Germany, West Germany, Hungary, India, Japan, 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 level.

[2] Revised to none.

[3] Produced in part from imported material.

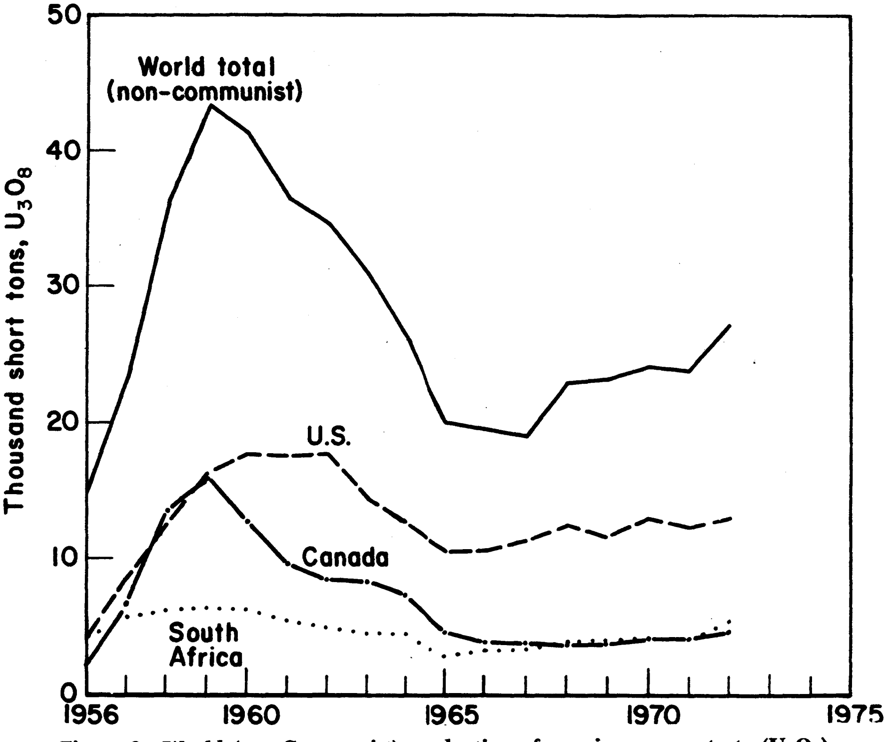

Figure 3.—World (non-Communist) production of uranium concentrate (U_3O_8).

made to present a united front to uranium buyers, and a quota system and minimum price standards were under consideration.[22]

Western Europe and Japan, the principal future (non-Communist) world markets for uranium outside the United States, continued efforts to assure supply of U_3O_8 and enriched uranium. Bilateral and multinational arrangements were made for U_3O_8 supply from Australia, Canada, Niger, and the Territory of South-West

[22] Mining Journal. Producers Meet in Johannesburg. V. 278, No. 7140, June 23, 1972, pp. 514–515.

Africa, and negotiations for uranium facilities involved Western Europe, Japan, and the producing countries, including the United States. Technical assistance was underway in uranium development, and joint manufacturing and marketing companies were formed.

In February, a French initiative resulted in a Western Europe study group, comprising seven nations, on gaseous-diffusion enrichment. The nations considered the pooling of knowledge and experience, development of cooperative programs, and the integration of activities on gaseous-diffusion technology.

The EC announced a nuclear program for better organization of the member Euratom nations to reduce or eliminate partitioning of the EC market and for resolving environmental problems inherent in nuclear energy.[23] Nuclear capacity was projected at 12,000 megawatts in 1975; 45,000 megawatts in 1980; a minimum of 100,000 megawatts (one-third of total electrical generating capacity) in 1985; and 620,000 megawatts in 2000. Orders for 75,000 megawatts of nuclear generating capacity were established as a minimum target during 1972–80. Cumulative Euratom demand was estimated at 55,000 tons U_3O_8 in 1985. U_3O_8 reserves within or controlled by the EC were 75,000 tons U_3O_8.

USAEC–EC representatives met to consider increased EC quotas for enriched uranium from the United States.[24] The existing quota was 215 tons SWU per year; the EC sought a ceiling of 450 tons SWU or assurance of supply on a nondiscriminatory basis. EC policy on future enrichment capacity and supply was under study.

During 1972, the EC concluded 21 contracts for 9,505 tons U_3O_8 and 12 toll enrichment contracts with the AEC for $192.7 million.

Rest-of-world operable nuclear capacity was nearly 20,000 megawatts at the end of the year, compared with nearly 15,000 megawatts operable in the United States.[25] Japan had the largest capacity under construction or planned. Foreign capacity was expected to reach 160,000 megawatts in 1980 and more than 2 million megawatts in 2000. Foreign non-Communist enrichment capacity was expected to remain lower than demand.

[23] Commission of The European Communities, Directorate-General for Energy and Euratom Safeguards. Second Illustrative Nuclear Programme for the Community. July 1, 1972, 84 pp.
[24] Metal Bulletin. EEC'S Uranium Supply. No. 5704, June 2, 1972, p. 21.
[25] United States Atomic Energy Commission, Office of Planning and Analysis, Forecasting Branch. Nuclear Power, 1973–2000. WASH-1139(72). Dec. 1, 1972, 42 pp.

Table 17.—Projected foreign nuclear power capacity and uranium demand, 1980–2000 [1]

Year	Capacity (megawatts)			Demand [2] (short tons U_3O_8)
	Non-Communist	Communist	Total	
1980	140,500	19,500	160,000	42,900
1985	303,000	56,000	359,000	78,600
1990	580,000	146,000	726,000	120,500
2000	1,460,000	600,000	2,060,000	201,200

[1] Most likely estimate.
[2] Non-Communist nations only.

Source: U.S. Atomic Energy Commission, Office of Planning and Analysis.

Table 18.—Projected foreign capacity and demand for enriched uranium, 1980–2000 [1]

(Thousands of separative work units per year)

Year	Capacity		Demand		
	High	Low	High	Low	Most likely
1980	2,700	1,800	15,200	11,700	13,800
1985	12,800	10,250	34,300	23,000	27,900
1990	28,000	23,250	60,600	35,400	47,700
2000	52,200	34,200	115,100	59,500	84,600

[1] Non-Communist nations only.

Source: U.S. Atomic Energy Commission, Office of Planning and Analysis.

Australia.—Whereas uranium exploration slackened worldwide, it was at a record level throughout Australia, particularly in the Northern Territory and Western Australia. More than 80 Australian and international companies were directly or indirectly involved. Significant discoveries were reported in the Northern Territory, Queensland, South Australia, and Western Australia. Broad aerial and ground surveys and extensive drilling activity continued throughout the year.

Established reserves were estimated as follows:[26]

Location	Property	Reserves: Quantity (tons U_3O_8)	Reserves: Average grade of ore (% U_3O_8)
Northern Territory	Ranger 1 and 3	91,000	0.34
Do	Nabarlek	11,600	2.37
Do	Jim Jim	NA	NA
Queensland	Westmoreland	15,400	.15
Do	Mary Kathleen	9,600	.12
Do	Miscellaneous	6,800	.15
South Australia	Lake Frome	13,800	.20
Do	Mount Painter	3,400	.11
Western Australia	Yeelirrie	50,000	.16

NA Not available.

This estimate indicates total reserves of more than 200,000 tons U_3O_8, exclusive of the Jim Jim deposit in the Northern Territory, where exploratory drilling continued at yearend. Some of these reserves, however, would not be economic at 1972 prices.

The Australian Atomic Energy Commission (AAEC) reported reserves, recoverable at $10 per pound U_3O_8, of 167,000 tons measured and indicated and 92,000 tons reasonably assured resources.[27] This reserve estimate excludes Western Australia.

Regardless of the magnitude of the reserve estimate, Australia was expected to become a major world supplier of uranium. The AAEC projected domestic demand of 2,000 to 3,000 tons U_3O_8 per year to 1990 and cumulative demand of 50,000 tons U_3O_8 to 2000; large supplies will be available for the export market. The AAEC anticipated a production rate of 12,000 tons U_3O_8 per year by 1982 and uranium exports valued at $200 million by 1980.

Ranger Uranium Mines Pty. Ltd. planned a mining rate of 3,000 tons U_3O_8 per year by 1976 at the Ranger mine, Northern Territory, the largest uranium mine in the country. The operation, to include a solvent extraction mill, was scheduled to produce 1 million tons of ore per year, averaging 0.20% U_3O_8.[28] In November, the Government approved contracts with two Japanese utility companies for delivery of 6.6 million pounds U_3O_8 during 1977–86. Another sales contract was announced for 17.3 million pounds U_3O_8, valued at more that $106 million, also with Japan, from the Nabarlek deposit, Northern Territory.[29] Nearly 10 million pounds U_3O_8 are committed in several sales contracts negotiated by Mary Kathleen Uranium Ltd. for the Mary Kathleen mine, Queensland, which was scheduled to re-open in 1974. At yearend, six uranium export contracts had been approved.

The discovery of uranium by Western Mining Co. Ltd. (WMC) at Yeelirrie, Western Australia, the first significant uranium discovery in the state, triggered a uranium rush which spread to several areas of the state. Hundreds of square miles were claimed, and other discoveries were reported during the year. Late in the year, WMC announced ore reserves of 35 million tons of ore, averaging 0.16% U_3O_8, in a mineralized area 5 miles long and 0.5 mile wide.

Australian authorities negotiated with the French and Japanese regarding the technical and economic feasibility of establishing a uranium enrichment plant in Australia.[30] The Minister for National De-

[26] Geological Survey of Queensland (principal source). Queensland Government Mining Journal. September 1972, pp. 364–367.

[27] Australian Atomic Energy Commission. Twentieth Annual Report 1971–72. August 1972, p. 60.

[28] Engineering and Mining Journal. Development of Ranger Uranium Mine in Australia Estimated at $72 Million. V. 173, No. 7, July 1972, p. 29.

[29] Mining Journal. V. 279, No. 7164, Dec. 8, 1972, p. 466.

[30] Mining Journal. Australia Looks to Enrichment. V. 279, No. 7159, Nov. 3, 1972, p. 351.

velopment announced a new policy providing access by Australian companies to nonclassified information on uranium enrichment held by the Government. Studies were underway in the various states to locate potential sites for enrichment plants. In October, the Government of Western Australia submitted a proposal to the Commonwealth Government for a $6.8 billion integrated industrial complex, including a 7,000-ton-per-year enrichment plant.

According to the Minister for National Development, a decision on the proposed Jervis Bay nuclear powerplant was deferred for the second time, pending clarification of a number of circumstances, including safety criteria for the light water reactor (LWR) in the United States and a decision on the next generation of power reactors in the United Kingdom.

Canada.—Mine and mill production continued at only three operations—Rio Algom Mines Ltd. and Denison Mines Ltd., both in the Elliot Lake area, Ontario, and Eldorado Nuclear Ltd., Uranium City, Saskatchewan. U_3O_8 output increased 19%, reaching 9,796,000 pounds. Rio Algom operated its new Quirke mine at full capacity of 6,500 tons of ore per day from seven working levels.[31]

In February, construction started on the $50 million mine and mill complex of Gulf Minerals Canada Ltd., Gulf Oil Canada Ltd., and Uranerz Canada Ltd., at Rabbit Lake, northern Saskatchewan. An open pit mine will be developed to a depth of 400 feet. The new mill, with annual capacity of 4.5 million pounds U_3O_8, was scheduled for operation in 1975.[32]

As in 1971, exploration for uranium remained at a reduced level. A continuing soft market and uncertainty concerning Government policy on foreign ownership of uranium properties provided little incentive for investment in exploration.

Canada assumed a leading role as supplier of U_3O_8 in world markets. At the beginning of the year, outstanding contracts for Canadian uranium, for delivery in the early 1980's, totaled 61,000 tons, 85% of which was for export.[33] Commitments or guaranteed sales, including options, from 1966 through 1971 total 74,900 tons U_3O_8 primarily to Japan, West Germany, United Kingdom, and the domestic market.[34] In February, sale of 8.9 million pounds U_3O_8, valued at $60 million, was announced for delivery to Spain during 1974–77. This supply would be provided from the joint Denison Mines Ltd.–Government stockpile.

In August, atomic energy control regulations were amended, defining authority of the Atomic Energy Control Board (AECB) in withholding uranium export permits where prices or quantities specified in sales contracts are not in the public interest.

The Pickering-2 CANDU power reactor, the second of four 540-megawatt units planned at the site, was dedicated in February and performed well throughout the year. Pickering-3 and -4 were scheduled for completion in 1973 and 1974, respectively. In addition, construction of Bruce-1, first of four 800-megawatt units, was scheduled for completion in 1975.

An Atomic Energy of Canada Ltd. (AECL) study projected quantities of spent fuels as follows:[35] 28,000 cubic feet in 1980, 177,000 cubic feet in 1990, and 565,000 cubic feet in 2000. The AECL was assessing methods for long-term storage. The fuel cycle for natural uranium fuels, used in the CANDU reactor, does not involve reprocessing; the spent fuel is considered a waste product, and there are no current plans for recovery of any valuable constituents. The spent fuel bundles from the reactor are stored under water at the reactor site for 5 to 10 years. They then would be transferred to engineered long-term storage facilities (100 years or more), where they would remain subject to retrieval.

According to a National Energy Board forecast, power demand in Canada will increase fivefold by the end of this century, at which time more than one-half of electric generating capacity will be nuclear.[36] The Minister of State for Science and Technology estimated a cumulative investment of more than $10 billion in commer-

[31] The Mining Record. Rio Algom's Uranium Mine in Full Operation. V. 83, No. 8, Feb. 23, 1972, p. 1.

[32] Northern Miner. Fluor Utah Building Gulf's Uranium Mill. V. 58, No. 4, Apr. 13, 1972, p. 19.

[33] Northern Miner. Strong Future Awaiting Uranium but Needs Right Price to Mine. V. 58, No. 8, May 11, 1972, pp. 13–14.

[34] Williams, R. M. Uranium and Thorium. Ch. in Canadian Minerals Yearbook 1971. Mineral Resources Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

[35] Atomic Energy of Canada Ltd. The Canadian Approach to Spent Nuclear Fuels. Nuclear Canada, v. 11, No. 7, September 1972, p. 6.

[36] Gray, J. L. Atomic Achievement. Chem. & Ind. (London), No. 15, Aug. 5, 1972, pp. 598–600.

cial nuclear development during the next 20 years.

France.—Mine production was at approximately the same level as in 1971. Average ore grade tended to increase. Efforts were made to improve operating methods and reduce costs.

In addition to estimated reserves of 45,000 tons U_3O_8 ($10 per pound) in metropolitan France, the Commissariat à l'Énergie Atomique (CEA) controlled uranium reserves totaling 50,000 tons U_3O_8 in Niger, Gabon, and the Central African Republic. Exploration by French companies, often joint projects, was conducted in Africa, Australia, Indonesia, and the United States.

The French negotiated in Western Europe, Australia, and Japan concerning cooperation in research and development in uranium enrichment, based on French gaseous diffusion technology. A multinational study group was organized with private and public interests in Belgium, West Germany, Italy, Netherlands, and the United Kingdom (Sweden and Spain were added later in the year) to form a new company, Eurodif, to work with the CEA on economics of a commercial operation.

The Phénix 250-megawatt prototype LMFBR was scheduled for operation at Marcoule in 1973. A cooperative agreement was concluded with West Germany and Italy on a 1,000-megawatt fast breeder, construction of which would start in 1974. A 10-year joint fast-breeder program was negotiated with Japan.[37] Technicatome, an LMFBR engineering company, was created by the CEA (90%) and Electricité de France (10%).[38] This company let a contract for bid specifications for a 1,200-megawatt fast breeder.

Westinghouse Electric Co. joined with Péchiney-Ugine-Kuhlmann (PUK) in a LWR nuclear fuel venture.

Germany, West.—The Government budgeted $8 million for sponsoring uranium exploration in 1972. Projects were underway in northeast Bavaria; the Salzburg, Arlberg, and Tirol areas of Austria; Niger, Mali, Ghana, Togo, and the Territory of South-West Africa; Australia; Canada; and the United States.[39] The Government withdrew financial support for the mining project at Rossing, South-West Africa. With an 8.5% interest in the Arlit deposit in Niger, West German shipments of uranium concentrate will start in 1974 and reach 150 tons per year. Exploration activity in Australia was with Italian and Australian interests. In Canada, Uranerz Canada Ltd. has a 49% interest in the Rabbit Lake project in Saskatchewan. In the United States, joint exploration with Atlantic Richfield Corp. was underway in the Chama Basin, N. Mex., and on concessions in Wyoming and Utah.

The pilot gas-centrifuge cascade at Juelich operated for a full year with reportedly good results. Uran-Isotopentrennungs G.m.b.H. (URANIT) was building a West German prototype centrifuge facility at Almelo, Netherlands, as part of a tripartite agreement on enrichment development with the Netherlands and the United Kingdom. The Almelo plant was scheduled for operation at a rate of 5 tons separative work per year early in 1973 and at 25 tons per year when additional cascades are completed later in 1973.

According to the Minister of Science, separative capacity per centrifuge was increased sixfold during the past 10 years. The decision was made to develop capacity of 300 tons per year by 1973 and 3,000 tons per year by 1980.

The Science Ministry projected cumulative U_3O_8 demand at 25,000 tons in 1980. Annual demand was 700 tons in 1972 and will be an estimated 5,500 tons in 1980. Separative work requirements were to be as follows, in kilogram SWU's:

Year	Annual	Cumulative
1975	1,700	5,000
1980	3,500	18,500
1985	8,500	78,000

Plans were made to start construction on a $333 million, 300-megawatt fast breeder reactor (FBR) at Kalkar, near the Netherlands border, in 1973. The project was sponsored by an international consortium comprising West Germany, Belgium, the Netherlands, and Luxembourg.[40]

[37] Wall Street Journal. France, Japan Sign 10-Year Agreement on Nuclear Energy. V. 179, No. 40, Feb. 28, 1972, p. 28.

[38] Atomic Industrial Forum. France Creates Breeder Firm. Nuclear Ind., v. 19, No. 7, July 1972, p. 32.

[39] Mining Magazine (London). West Germany's Uranium Search. V. 126, No. 5, May 1972, pp. 325, 327.

[40] Hafele, W., and G. Kessler. SNR: The German-Benelux Fast Breeder. Nuclear News, v. 15, No. 3, March 1972, pp. 48–53.

Japan.—The Japanese Government sought means of diversifying uranium supply sources and assuring future supply by seeking joint foreign agreements on exploration, mining, and enrichment services. In February, Japanese utility companies concluded contracts with the United States for purchases of up to 369 tons (335 metric tons) of enriched uranium per year for 26 years. Cooperative agreements were also made with France, Australia, Canada, West Germany, and the United Kingdom. Survey missions were active in several African countries and Mexico. An Enrichment Survey Committee was formed to study proposals for Japanese participation in foreign enrichment projects.

Negotiations for enriched uranium included construction of an enrichment plant in Japan or in the United States. Reynolds Metals Co. proposed a joint venture with a number of Japanese utility companies.[41] As part of a United States-Japan trade agreement, Japan would prepay $320 million for 10 million SWU's in enrichment services, the uranium coming from the United States preproduced inventory of enriched uranium. A joint working group would be formed with the USAEC on the feasibility of a joint gaseous diffusion facility in the United States.[42]

Two major Japanese power companies will purchase 3,300 tons U_3O_8, valued at $40 million, from Ranger Uranium Mines Ltd., Northern Territory, Australia, during 1977–86; 1,000 tons U_3O_8 from Mary Kathleen Uranium Ltd., Queensland, Australia; and 2,200 tons U_3O_8 from Queensland Mine Ltd., Australia.[43]

A White Paper, prepared by the Science and Technology Agency (STA), predicted a uranium supply crisis if the Japanese did not participate in foreign enrichment and develop their own enrichment technology. Research and development were centered around the Japanese Atomic Energy Research Institute and Nuclear Fuels Corp. The Uranium Enrichment Technical Development Council, an advisory group to the Japanese Atomic Energy Commission (JAEC), recommended a national research and development project on gas centrifuge technology and fundamental research on gaseous diffusion. Ten centrifuges, installed at Tokai, were scheduled for operation in 1973.

Two nuclear fuel processing and fabricating companies were formed—Mitsubishi Nuclear Fuel Co. and Japan Nuclear Fuel Co. Plans called for UO_2 and fabrication capacity of 450 tons per year by 1975.[44] Allied Gulf Nuclear Fuel Services, Inc., a United States firm, and the Mitsubishi Group agreed to a $130 million joint-venture nuclear fuel reprocessing plant. Initial capacity would be 5 tons per day, operable in 1983 in either the United States or Japan.

Studies were also initiated on radioactive waste management. STA considered the more remote Japanese islands as possible sites for waste storage. Islands off the south and west coasts of Kyushu were investigated.

According to the JAEC, nuclear generating capacity was nearly 1,300 megawatts in 1972. Projections were 14 nuclear powerplants (8,000 megawatts) in 1975; 32,000 megawatts in 1980; 60,000 megawatts in 1985; and 100,000 megawatts in 1990.

The Central Electric Power Council forecast a 10.5% growth rate for electric power demand through fiscal year 1980 and the need for 149,070 megawatts of new capacity (66,880 megawatts nuclear). Plans called for 34,100 megawatts nuclear capacity in 1980 and a further 5,700 megawatts under construction in 1980–81.

South Africa, Republic of.—According to the Chamber of Mines of South Africa, production of U_3O_8 was slightly reduced from the 1971 rate. Uranium was recovered as a byproduct at nine gold mines and was the primary product at operations of West Rand Consolidated Mines, Uranium Section. The principal uranium-producing mines were Vaal Reefs and Buffelsfontein. Material processed for uranium totaled 16.1 million tons at an average grade of 0.5 pounds U_3O_8 per ton.

Although only 11 mines were uranium producers, 27 mines were capable of supporting uranium production, and 17 mines had uranium extraction plants.

Reserves were reported at 300,000 tons

[41] American Metal Market. Joint Uranium Pact Proposed for Japan, United States, Says Report. V. 79, No. 174, Sept. 22, 1972, p. 7.
[42] Atomic Industrial Forum. Japan Ready to Discuss Joint Venture Diffusion Plant in United States. Nuclear Ind., v. 19, No. 9, September 1972, pp. 14–15.
[43] Metal Bulletin. Ranger Concentrates for Japan. No. 5729, Sept. 1, 1972, p. 18.
[44] American Nuclear Society. New Companies Formed. Nuclear News, v. 15, No. 1, January 1972, p. 42.

U_3O_8 (\$10 per pound U_3O_8), a substantial increase over previous reports, and apparently included approximately 100,000 tons U_3O_8 for the Rossing property, South-West Africa.

A calcined uranium product of 98%–99% U_3O_8 purity was recovered as a byproduct at the Palabora copper mine, where U_3O_8 production was started in 1971. Tailings from copper concentration, after desliming and removal of magnetite, were fed to a recovery plant at an average rate of 22,000 tons per day. Gravity concentration and shaking tables produced three product streams, including a uranothorianite concentrate containing 5% U_3O_8, which went to a chemical extraction plant, where uranium (and thorium) were recovered by leaching and solvent extraction.[45]

Tenders were let for South Africa's first nuclear powerplant, at Duinefontein, north of Cape Town. This 500-megawatt installation was scheduled for operation in 1979.

United Kingdom.—The Atomic Energy Authority (AEA) continued development work on the MK II and MK III (advanced gas-cooled reactors—AGR), the steam-generating heavy-water reactor, and the FBR.[46] Progress was made on construction of the 250-megawatt prototype FBR at Dounreay, which was scheduled for completion in 1973. Development work continued on a program for a 1,000-megawatt FBR.

The first cascade of the gas-centrifuge uranium enrichment plant at Capenhurst went into operation. This project is part of a tripartite (United Kingdom, West Germany, and the Netherlands) program for development of a commercial enrichment capability. British Nuclear Fuels, Ltd., was adding 100 centrifuges weekly and planned completion of a 15-ton-per-year pilot plant in 1973.

The first nuclear development program, including nine commercial nuclear powerplants, based on natural uranium-gas-graphite reactors, was completed. Under the second program, which was based on the AGR, using enriched uranium fuel, six plants comprising 14 reactors (8,750 megawatts) were under construction by the Central Electricity Generating Board at yearend.[47] Operations at several plants were slowed by a corrosion problem concerning 9% chrome steel. This problem was also likely to affect AGR planning.

U.S.S.R.—The 350-megawatt (thermal), dual-purpose (electric power and desalination) FBR at Shevchenko, on the northeast shore of the Caspian Sea, went critical during the year. A problem was encountered due to fuel pin swelling. The U.S.S.R. nuclear power program is based on PWR's and large-capacity graphite-water reactors. A 2,000-megawatt, two-unit installation of the latter type was under construction at Leningrad. Plans call for 30,000 megawatts of nuclear electric capacity by 1980. A large-capacity LMFBR was planned for the early 1980's. In addition to the Shevchenko unit, a 600-megawatt FBR was under construction in the Ural Mountains.[48]

Other Countries.—In Western Europe, all nations had interest in uranium development and/or plans for internal nuclear power development. In Austria, construction was started on the first nuclear powerplant, a 700-megawatt BWR, located at Zwenterdorf, on the Danube River.

Belgium had an 870-megawatt unit and two 390-megawatt units under construction at Tihange and Doel, respectively.

In Denmark, the Jutland-Funen Elecricity Cooperation (ELSAM), a federation of companies with seven power stations, requested meetings with the Danish Atomic Energy Commission on a first nuclear unit, of 600-megawatt capacity, proposed for the Copenhagen area. The Commission announced discovery of a uranium deposit, covering an extensive area in the Kvane Mountains of southwest Greenland.[49]

In Finland, two units (860 megawatts) of U.S.S.R. design were under construction at Loviisa, east of Helsinki, and a third unit was planned near Rauma, on the west coast. According to the Finnish State electric utility company, planning includes a

[45] Nel, V. Palabora's New Heavy Minerals Plant Adds Uranium Concentrate to the Recovery List. Eng. and Min. J., v. 173, No. 11, November 1972, pp. 186–187.

[46] United Kingdom Atomic Energy Authority. Electricity Generation: Reactor Development. Ch. 2 in Eighteenth Annual Report and Accounts, 1971/72. Pages 8–18.

[47] American Nuclear Society. Common Market Gains a Strong Partner. Nuclear News, v. 16, No. 2, February 1973, p. 40.

[48] Atomic Industrial Forum. A Straightforward Review of the Soviet Union's Reactor Program. Nuclear Ind., v. 19, Nos. 11–12, pt. 1, November–December 1972, pp. 26–29.

[49] Mining Journal. Greenland Uranium Mine? V. 279, No. 7159, Nov. 3, 1972, p. 354.

Table 19.—Status of foreign nuclear power reactor development [1]

(Megawatts electric)

Country	Reactors	
	Operable	Under construction or planned [2]
Argentina	--	2,318
Australia	--	800
Austria	--	700
Belgium	--	1,650
Brazil	--	626
Bulgaria	--	880
Canada	1,974	3,508
Czechoslovakia	--	1,760
Finland	--	1,480
France	2,481	4,800
Germany, East	70	1,760
Germany, West	2,082	13,913
India	600	1,040
Italy	597	1,566
Jamaica	--	400
Japan	1,756	30,664
Korea, Republic of	--	2,328
Mexico	--	1,200
Netherlands	55	1,050
Pakistan	125	200
Philippines	--	420
Romania	--	880
South Africa, Republic of	--	500
Spain	1,100	8,798
Sweden	440	9,620
Switzerland	1,006	2,400
Taiwan	--	2,808
Thailand	--	500
United Kingdom	5,335	9,144
Yugoslavia	--	600
U.S.S.R.	2,351	9,370
Total	19,972	117,683

[1] Yearend 1972.
[2] Completion dates scheduled.

Source: U.S. Atomic Energy Commission, Office of Planning and Analysis.

nuclear power unit every 2 years.[50] The third unit will be the first involving private funds; 16 industrial firms will own 60%, the remainder being publicly owned.

In Greece, the Public Power Corp. and the Hellenic Atomic Energy Commission planned a 600-megawatt plant, the first of eight proposed. Three units would be in operation in 1985 (21% of total generating capacity), and nuclear capacity totaling 4,200 megawatts would be in operation in 1990 (36% of total generating capacity).[51]

AGIP Nucleare, Italy, was active in uranium exploration in Australia, Somalia, the United States (jointly with Denison Mines Ltd. in Wyoming, Montana, and South Dakota), and Zambia. According to Ente Nazionale per l'Energia Elettrica (ENEL), the State-owned electric utility company, future operable nuclear capacity would be as follows: 5,500 to 6,500 megawatts in 1980; 16,000 to 20,000 megawatts in 1985; and 44,000 to 60,000 megawatts in 1990.

In the Netherlands, a gas-centrifuge enrichment facility (annual capacity 25,000 kilograms SWU) started operations late in the year. According to the Ministry of Economic Affairs, the Netherlands nuclear power program, based on its share in EC projections, was as follows: 2,000 megawatts in 1980; 8,000 megawatts in 1990; and in excess of 20,000 megawatts in 2000, when about half the total installed capacity would be nuclear.

In Spain, the Ministry of Industry authorized Empresa Nacional del Uranio S.A. (ENUSA) to evaluate domestic uranium resources; develop mining and processing techniques; conduct enrichment, nuclear fuel, and fuel-reprocessing studies; and negotiate with foreign suppliers on behalf of Spanish companies. ENUSA was in charge

[50] Engineering News-Record. Soviet-Engineered Nuclear Plant Uses U.S. and Western Systems. V. 189, No. 2, July 13, 1972, p. 18.
[51] American Nuclear Society. Nuclear News Briefs. Nuclear News, v. 15, No. 2, February 1972, p. 51.

of development of the Ciudad Rodrigo uranium deposit, Salamanca province, and exploration in Soria and Sevilla provinces. Reserves were estimated at 10,000 tons U_3O_8 ($10 per pound U_3O_8); 9,000 tons ($10–$15); and 5,000 tons ($15–$20). The Spanish Government completed a $60 million purchase from Canada for 8.9 million pounds U_3O_8 (average $6.50 per pound) for 1972–77.[52] Late in the year, commitments were made for two more PWR's in the 900- to 1,000-megawatt class, the sixth and seventh PWR's from Westinghouse in little more than 1 year. The Spanish National Electricity Plan called for 8,000-megawatt nuclear capacity in 1980 and 15,000-megawatt nuclear capacity in 1983.

In Sweden, the Geological Survey sought increased funds for uranium exploration, including airborne surveys in Lappland, where uranium was discovered.[53] The State Power Board and A.B. Atomenergi planned a 3-year research-and-development project at Ranstad, where grade is low (0.03% U_3O_8) and high-cost reserves extensive (270,000 tons U_3O_8). This project was aimed at greater operating efficiency, possible recovery of molybdenum and vanadium, and improved extractive methods. The Ranstad mine was maintained on a standby basis because production costs exceeded the world price for uranium. Six nuclear powerplants were under construction, and a 8,200-megawatt nuclear capacity was expected in 1980.

In addition to a 1,000-megawatt nuclear capacity operable in Switzerland, six large capacity plants were approved or being planned.

Radiometric anomalies were recorded over an extensive area in Slovenia, Yugoslavia. Further investigation led to discovery of a possibly economic deposit at Zirovski Vrh, where development was underway. Plans continued on the Krsko nuclear powerplant, a Slovenia-Croatia project and Yugoslavia's first.

Among the Communist-bloc nations in Europe, a 440-megawatt PWR under construction in Bulgaria was scheduled for completion in 1975; a second unit was planned at the same site. A small capacity operable unit in Czechoslovakia is gas cooled and heavy water moderated; four PWR's were committed.

In Latin America, nuclear power was considered important to future development in Argentina, where several CANDU-type plants (1,900 megawatts) were planned for 1980.[54] A CANDU installation at Atucha, 60 miles northwest of Buenos Aires, is Latin America's first nuclear powerplant and was expected to be operable in 1973, 1 year behind schedule. No decision was made on the type of reactor planned for Cordoba province. Exploration for uranium deposits was underway in four regions. Domestic reserves were estimated at 16,000 tons U_3O_8. The Comisión Nacional de Energía Atómica planned a mine and mill in Sierra Pintada, Mendoza Province, where production at a rate of 400 tons U_3O_8 per year was scheduled for 1977.

Homestake Mining Co. expressed interest in a uranium exploration program in Bolivia.

In Brazil, Companhia Brasileira de Tecnologia Nuclear (CBTN) was organized to construct a mill for processing ore from Poços de Caldas, Minas Gerais, and plan a nuclear fuels industry. Uranium was discovered near Belo Horizonte, Moeda Range, Municipio Brumadinho, with West German assistance; drilling was planned. Late in the year, construction started on a PWR in the 600-megawatt category at Angra dos Reis, Sepetiba Bay, 90 miles southwest of Rio de Janeiro.

Mexico made plans for its first nuclear unit, a 660-megawatt BWR at Laguna Verde, 55 miles north of Vera Cruz. A joint United States-Mexico group will study possibilities for nuclear electric power and water desalination.

Among the African nations, Société Nationale de Recherche et d'Exploitation Minière (SONAREM), the State mining agency in Algeria, reported a uranium discovery in the Hoggar area, deep in the Sahara Desert. In Angola, a joint exploration venture between the Portuguese Nuclear Energy Board and Urangesellschaft m.b.h. covered the Dondo, Malange, and Moxico areas. Uranium concentrate production of Société des Mines de l'Air at Arlit in Niger was at full capacity. Plans to double output were delayed. Japanese-CEA exploration established ore reserves at Akokan; a

[52] Northern Miner. Spanish Uranium Deal Finally Made Official. V. 58, No. 38, Dec. 7, 1972, p. 17.

[53] Engineering and Mining Journal. V. 173, No. 12, December 1972, p. 9.

[54] Canada Commerce. Argentina Comes of Nuclear Age. V. 136, No. 5, May 1972, pp. 20–21.

feasibility study was made for a mine-mill project. Exploration by Somiren S.p.A., subsidiary of Ente Nazionale Idrocarburi, the Italian national company, continued in Somalia, where large, low-grade resources were identified.

The West German Government withdrew financial support at the Rossing project, Territory of South-West Africa, where production was scheduled for 1976. Urangesellschaft m.b.h. may continue support with Rossing Uranium Ltd. A number of companies, including the major South African mining groups, continued exploration in the area. Western Knapp Engineering Division of Arthur G. McKee and Co., San Francisco, Calif. and Power Gas Ltd., London, were granted a contract for design, engineering, procurement, and construction at the project.[55]

In the Far East, India planned self-sufficiency in uranium resources and emphasis on CANDU-type reactors to avoid dependence on foreign enriched uranium. Uranium Corp. of India Ltd., a Government-owned company, planned to deepen the Jaduguda mine, Bihar, to 2,000 feet. Reserves in Bihar were estimated at 50,000 tons U_3O_8 in low-grade ore. Mill capacity of 1,000 tons of ore per day would supply the four 200-megawatt CANDU units under construction. The company also planned a uranium-recovery circuit at the Surda copper refinery, Bihar. A Ten Year Profile on Atomic Energy, presented by the Indian Atomic Energy Commission, proposed 2,700 megawatts of nuclear capacity by 1984, design and construction of a prototype FBR, and development of gas-centrifuge technology, a nuclear fuels industry, and fuels-reprocessing facilities.

In Pakistan, a United Nations Development Program was assessing the Dera Ghazi Khan deposits, where drilling was in progress. A pilot plant at Lahore will process 1,000 pounds of ore daily. The Japanese were assisting the Pakistani Atomic Energy Commission (PAEC) in uranium exploration. Pakistan's first nuclear powerplant, located 27 miles west of Karachi, went to full power operation in October. It is a 125-megawatt CANDU type reactor, built with Canadian assistance.

In Taiwan, two 600-megawatt BWR's were under construction at Chinsan, and two larger-capacity BWR's were ordered for a location in the north.

TECHNOLOGY

The isotope U_{236} was observed for the first time in natural ores on earth. This observation followed its discovery in lunar samples from the Apollo 14 flight. Extremely sensitive mass spectrometers that masked U_{235} were used in detecting the U_{236}. U_{236} was more abundant in the lunar samples.

A new concept on uranium deposition led to a better understanding of the origin of Tertiary uranium deposits in Wyoming.[56] According to this theory, a geochemical cell develops with oxygenated ground water in a reducing environment in sediments below the water table. Destruction of carbonaceous material, oxidation of pyrite, and accumulation of uranium occur in a wave or front ahead of the invading oxidizing environment.

New equipment was under development for use in uranium exploration and radiation monitoring. A highly sensitive scintillation detector, developed by the Westinghouse Nuclear Instrumentation and Control Department, will monitor gamma radiation particles in air. It was designed for environmental safety surveillance in and near nuclear powerplants.[57]

A technique, called Track Etch, was developed at General Electric Co. laboratories for minimum exploration time with no environmental disturbance. The instrument measures the concentration of radon gas and records data on a special film, which was placed in small plastic cups. The technique may be used in early exploration to delineate favorable trends or zones, in conjunction with airborne surveys, in defining radon anomalies near known ore bodies, and in analyzing radon concentration in exploratory drilling by lowering the film cups into drill holes.[58]

---

[55] Metal Bulletin. Uranium Plant Contract. No. 5692, Apr. 18, 1972, p. 17.
[56] Rackley, R. I. Environment of Wyoming Tertiary Uranium Deposits. AAPG Bull., v. 56, No. 4, April 1972, pp. 755–774.
[57] American Nuclear Society. Radiation Detector. Nuclear News, v. 15, No. 7, July 1972, p. 65.
[58] Mining Record. General Electric Develops Track Etch Uranium Exploration. V. 83, No. 44, Nov. 1, 1972, p. 3.

Another procedure measures the earth heat flux in drill holes, anomalous radioactive heat sources being indicative of the presence of uranium.[59]

A neutron source, such as Californium$_{252}$, may present a fairly accurate estimate of grade in drill holes, reducing the need for chemical assays.[60] The ore zone is irradiated with bursts of fast neutrons. Neutrons detected between bursts are indicative of delayed neutron emissions from fission in a uranium source.

Studies were reported on uranium recovery from seawater. Investigations by the United Kingdom Atomic Energy Authority indicated that the uranium concentration in seawater is 15.3 tons per cubic mile, with uranium in solution as the $UO_2(CO_3)_2$ complex, and that the uranium may be recoverable at £15,000 to £30,000 per metric ton U (which corresponds approximately to $70 to $140 per pound U_3O_8). Hydrated titanium oxide in granular form was tested as a uranium absorber in a pilot plant which treated 4,000 cubic meters of seawater per week.[61]

The Power Reactor and Nuclear Fuel Development Corp. of Japan developed a simple, relatively low-cost method for extraction of uranium from seawater.[62] The absorbent material was sawdust, processed with 3.5% hydrochloric acid and soaked in 0.2% caustic soda solution. In a test, 1 gram of the absorbent was sufficient to extract uranium from a solution of 0.003 milligram of ionized uranium per liter.

Stress measurements in mines, laboratory tests on compressive rock strength, geologic study to evaluate tectonic stresses, and a survey on mining conditions and pillar configuration were conducted in the Elliot Lake mining district, Ontario, Canada.[63] Considerations in evaluating pillar design were pillar size, depth of mining, rate of extraction, and stress data.

New solution mining techniques for uranium were under investigation. In one procedure, oxygen was injected as an oxidant into development and production wells in a grid pattern to drive formational water from the producing area. An acid solution was then injected into the ore body, and the leach liquor containing the dissolved uranium salts was pumped to the surface.[64] In another procedure for in-situ uranium leaching from sulfide or carbonate ore bodies, oxygenated foam, air, or other oxygen-bearing gas was injected prior to or simultaneous with ammonium carbonate, sodium carbonate, or sulfuric acid as the leach solution.[65]

The Atomic Energy Board, Republic of South Africa, reported research and pilot-plant tests on a continuous countercurrent ion exchange column. More than 99.5% of the soluble uranium was recovered with a resin inventory less than one-third of that required by fixed-bed ion exchange.

A wet process for UF_6, in contrast to the usual dry method of obtaining UF_4 as an intermediate step, was under study in Japan.[66] Uranium is dissolved with hydrochloric acid and recovered by electrolytic reduction with a special ion-exchange resin and platinum electrode. The benefits reportedly were fewer processing stages, and lower temperature needed (100° C), resulting in reduced cost in plant and operation.

ACE nuclear fuels research was directed primarily toward behavior properties and performance data on uranium-plutonium oxide LMFBR fuels.[67] The objective was a fuel capable of operating efficiently in an LMFBR environment (1,200° to 1,400° F) while achieving an average burnup of 100,000 megawatt-days per ton (MWD/T) of fuel and a peak burnup of 150,000 MWD/T. Mixed (uranium-plutonium) oxide fuel pins were tested in Experimental Breeder Reactor 2 at the National Reactor Testing Station, Idaho. Data were also obtained on mixed carbide and ni-

[59] Howell, E. P., J. E. Hardison, and W. M. Campbell (assigned to Atlantic Richfield Co.). Prospecting for Underground Uranium Ore Bodies. U.S. Pat. 3,714,832, Feb. 6, 1973.

[60] Givens, W. W., R. L. Caldwell, and W. R. Mills, Jr. (assigned to Mobil Oil Corp.). Method for Assaying Rock Formations In-situ. U.S. Pat. 3,686,503, Aug. 22, 1972.

[61] McKay, H. A. C. By-products of Nuclear Power. Chem. & Ind. (London), No. 52, Dec. 25, 1971, pp. 1471–1472.

[62] Mining Journal. Absorbent for Uranium. V. 278, No. 7137, June 2, 1972, p. 456.

[63] Hedley, D. G. F., and F. Grant. Stope-and-Pillar Design for the Elliot Lake Uranium Mines. Can. Min. and Met. Bull., v. 65, No. 723, July 1972, pp. 37–44.

[64] Rhoades, V. W. (assigned to Cities Service Oil Co.). Solution Mining of Uranium Values From Underground Uranium Ore Bodies Having a Considerable Water Saturation. U.S. Pat. 3,713,698, Jan. 30, 1973.

[65] Hard, R. A., and R. L. Ripley (assigned to Union Carbide Corp.). Method for Insitu Leaching of Values From an Underground Water-Saturated Uranium Ore Deposit. U.S. Pat. 3,708,206, Jan. 2, 1973.

[66] Journal of Mines, Metals and Fuels. New Technique for Speeding Up Uranium Ore Processing. V. 20, No. 1, January 1972, p. 26.

[67] Pages 13–15 of work cited in footnote 7.

tride fuels, which may afford higher thermal efficiencies and higher fuel densities necessary for a high breeding ratio.

Studies on irradiation performance, safety characteristics, fuel-cycle costs, and fuel pin design for nitride fuels at Battelle Memorial Institute indicated certain advantages of this type of fuel.[68] The mixed nitride fuels exhibited thermal stability at temperatures exceeding 2,500° C, low swelling rates as long as temperatures that permit agglomeration of fission gases are avoided, low percentages of fission-gas release, and high burnup rates without degradation in fuel behavior.

In the FBR, high fuel burnup would result in significant fission-produced impurities. Certain impurity particles were identified by scanning electron microscopy.[69] Their influence on fracture stress was investigated at room temperature. Purification procedures reducing both particle size and number of particles improved fuel strength.

In a temperature range where gas bubble growth causes nuclear fuel swelling, the rate of swelling is an exponential function of the temperature, indicating that the process is fundamentally associated with diffusional creep processes. Studies were made on external diametrical swelling rates in oxide, nitride, and carbide fuels at temperatures to 1,900° C.[70] Analysis of gas-bubble growth indicated that the long-term creep strength of nuclear fuels and cladding is an important factor in controlling swelling.

Fuel swelling is caused by an accumulation of fission products in pore spaces, which also influence the strength and ductility of the fuel and its cracking and swelling behavior. The effects of porosity in sintered polycrystalline UO_2 on fuel strength and deformation characteristics were assessed over a wide temperature range (500° C, 1,250° C, and 1,600 C). Porosity was varied by use of naphthalene in UO_2 powder. At the lower temperatures, fracture was brittle and transgranular and initiated from large pores present after fuel fabrication. Increased porosity caused marked reduction in strength. At the higher temperatures, plastic deformation preceded fracturing, and the effects of porosity were more complex.[71]

Cold-pressed and sintered UO_2 pellets, a common nuclear fuel form, and UO_2 powder were the subjects of a study on sintering behavior. An attempt was made to develop improved correlations and information on the mechanism of sintering.[72] The ratio of pore size to particle size was considered important. Green density below 40% of the theoretical led to progressively reduced rates of sintering but did not affect the sintering law or the apparent activation energy for sintering.

Efforts were made to improve fabrication techniques for uranium mononitride (UN) fuels, which have a high melting point, good thermal conductivity, and stability under radiation. During UN preparation, oxygen can enter the lattice; it was therefore necessary to establish the maximum oxygen solubility in the lattice under various temperatures and pressures. At 1,600° C, 4,400 parts per million of oxygen can enter the lattice; above this temperature, oxygen solubility decreased slightly.[73]

Research on mixed fuels in test reactors, preparatory to high endurance capabilities and high burnup rates necessary in the commercial LMFBR, indicated a need for fuel-sodium reaction studies and metallurgical studies on the swelling problem.[74]

A project was underway to develop a chemical flowsheet for converting uranium nitrate solution to ceramic-grade UO_2 powder having desired properties for uniform blending with ThO_2 powder and for pressing and sintering into high-density, homogenous fuel pellets for the LWBR. The LWBR fuel is ThO_2 in which 1%-6% U_{233} in UO_2 form is dissolved. Studies on UO_2 production included the effects of nitric acid content of uranyl nitrate, temperature of precipitation, pH of solution, and time

[68] Bauer, A. A. Nitride Fuels: Properties and Potentials. Reactor Technology, v. 15, No. 2, Summer 1972, pp. 87–104.

[69] Solomon, A. A. Influences of Impurity Particles on the Fracture of UO_2. J. Am. Ceramic Soc., v. 55, No. 12, December 1972, pp. 622–627.

[70] Chubb, W., R. F. Hilbert, V. W. Storhok, and D. L. Keller. Fission Gas Swelling of Refractory Nuclear Fuels. Materials Sci. and Eng., v. 9, No. 5, May 1972, pp. 293–300.

[71] Roberts, J. T. A., and Y. Ueda. Influence of Porosity on Deformation and Fracture of UO_2. J. Am. Ceramic Soc., v. 55, No. 3, March 1972, pp. 117–124.

[72] Woolfrey, J. L. Effect of Green Density on the Initial-Stage Sintering Kinetics of UO_2. J. Am. Ceramic Soc., v. 55, No. 8, August 1972, pp. 383–389.

[73] Javed, N. A. Oxygen Solubility in Uranium Mononitride Phase. J. Less-Common Metals, v. 29, No. 2, October 1972, pp. 155–159.

[74] Murray, P. Fast Breeder Fuel. Reactor Technol., v. 15, No. 1, Spring 1972, pp. 16–58.

of digestion on uranate cake consumption.[75]

During refueling at a commercial reactor site, flattening was discovered in sections of some unpressurized fuel rods in a PWR. The AEC made a study of fuel performance of zircalloy-clad unpressurized fuel rods. Densification and movement of the pellets apparently caused open space within the rods, and greater pressure on the outside caused flattening of the cladding. This appeared more likely to take place in unpressurized rods. Beginning in November, the AEC required applicants and licensees to prepare new safety analyses to include possible effects of fuel densification and associated phenomena.

Investigations on fuels, nuclear materials, and reactor components continued at LMFBR development facilities of the AEC. These projects included Experimental Breeder Reactor 2 at the National Reactor Testing Station, Idaho; the Fast Flux Test Facility, under construction near Richland, Wash.; and the Liquid Metal Engineering Center, near Canoga Park, Calif. Other AEC-sponsored projects included the high-temperature, gas-cooled reactor at ORNL, Pacific Northwest Laboratory, and cooperative work with Gulf General Atomic Co, (GGA), San Diego, Calif.; the Gas-Cooled Fast Reactor at Argonne National Laboratory, ORNL, and with GGA; the Molten-Salt Breeder Reactor at ORNL; and the light-water breeder reactor, for which a demonstration core was under development for installation at the Shippingport, Pa., station in 1975.

A new boiling water reactor (BWR) design, called the BWR/6, went on the market. The manufacturer announced that it produces 20% more power without increased size of reactor and supporting systems. Other advantages were increased coolant circulation capacity, increased capacity for steam separators and dryers, and more fuel bundles with improved internal arrangement in the reactor to give greater heat output.[76]

Progress was made toward development of a commercial offshore, barge-mounted nuclear powerplant. Facilities were planned for the manufacture of four plants per year, starting in 1975.[77] A "tuned hemisphere" floating platform concept offers stability and less costly construction. The platform is spherical, using the principle of secondary mass, which tunes natural roll frequency lower than that of conceivable waves.

In offshore powerplant siting, thermal effects would be minimized; the ocean provides an enormous heat sink for plant effluent. Studies indicated a water temperature rise of less than 2° F within a 5-acre area.[78] Underground reactor installation also was considered feasible; this would alleviate some environmental objections, although construction costs may be 10% higher than that for surface plants.

A rapid and sensitive method using uranium was under development for calibrating meters to measure oxygen concentration in sodium for the LMFBR.[79] Accurate measurement of oxygen concentration in the sodium coolant was considered important; oxygen concentration in the coolant is related to corrosion, which would lead to transfer of radioactive materials from the reactor core to other parts of the primary LMFBR system.

---

[75] Letinaker, J. M., M. L. Smith, and C. M. Fitzpatrick. Conversion of Uranium Nitrate to Ceramic-Grade Oxide for the Light Water Breeder Reactor: Process Development. Oak Ridge Nat. Lab., Metals and Ceramic Div., ORNL–4755, April 1972, 54 pp.

[76] American Nuclear Society. A New General Electric BWR. Nuclear News, v. 15, No. 5, May 1972, p. 33.

[77] Atomic Industrial Forum. Westinghouse Gambles on Barge Manufacturing Facility. Nuclear Ind., v. 19, No. 6, June 1972, pp. 20–23.

[78] Chemical Week. V. 111, No. 13, Sept. 27, 1972, p. 31.

[79] Isaacs, H. S. Calibration of Electrochemical Oxygen Meters in Sodium Using Uranium. J. Electrochem. Soc., v. 119, No. 4, April 1972, pp. 455–459.

Vanadium

By Harold A. Taylor, Jr.[1]

Domestic demand for vanadium was still weak in 1972, compared to the high of 1969, although it was stronger than last year. Overseas demand was also weak but becoming stronger. Domestic production, expressed as vanadium pentoxide recovered, did not change significantly from last year because the production decrease resulting from the shutdown of the Rifle mill was balanced by increases in output at other facilities. Exports of both ferrovanadium and vanadium ores and oxides were much smaller than in 1971, while imports of ferrovanadium were much larger. The Government sold all of its surplus vanadium pentoxide in May.

Legislation and Government Programs.—The General Services Administration (GSA) sold all its excess vanadium pentoxide, 5.6 million pounds, to three metal trading firms in May. A condition of sale was that the material could not be sold abroad as vanadium pentoxide. It must be converted to another vanadium product in this country in the event of export. The material sold consisted of 87 lots, the vanadium pentoxide contents of which ranged between 85% and 90%.

As of December 31, 1972, the Government had an inventory of 2,800 short tons of vanadium, the entire quantity in the national stockpile. Of this total, 1,200 tons was held as ferrovanadium and 1,600 tons was held as vanadium pentoxide.

Table 1.—Salient vanadium statistics

(Short tons of contained vanadium)

	1968	1969	1970	1971	1972
United States:					
Production:					
Ore and concentrate:					
Recoverable vanadium [1]	6,483	5,577	5,319	5,252	4,887
Value thousands	$23,143	$26,334	$34,923	$37,690	$30,867
Vanadium pentoxide recovered	6,149	5,906	5,594	5,293	5,248
Consumption	5,495	6,154	5,134	4,802	5,227
Exports:					
Ferrovanadium and other vanadium alloying materials (gross weight)	278	644	2,155	676	269
Vanadium ores, concentrates, oxides, and vanadates	463	258	973	260	176
Imports (general):					
Ferrovanadium (gross weight)	626	449	21	89	578
Ores and concentrates	31	--	--	--	--
World production	13,331	18,581	20,171	18,571	19,949

[1] Measured by receipts of uranium and vanadium ores and concentrates at mills, plus vanadium recovered from ferrophosphorus derived from domestic phosphate rock.

DOMESTIC PRODUCTION

The principal domestic source of vanadium continued to be the Colorado Plateau uranium-vanadium ores, but by an even more slender margin than in 1971. Both Arkansas vanadium ore and Idaho ferrophosphorus supplied an increased amount of vanadium. Most of the producing facilities processed such materials as vanadium-bearing oil residues, spent catalysts, vanadium-bearing residues from titanium dioxide production, and foreign vanadium-containing slags. Vanadium obtained by processing imported vanadium-

[1] Physical scientist, Division of Ferrous Metals.

Table 2.—Recoverable vanadium of domestic origin produced in the United States, by State

(Short tons of contained vanadium)

State	1968	1969	1970	1971	1972
Colorado	3,492	W	W	W	W
Utah	563	W	257	226	188
Other States [1]	2,428	W	W	W	W
Total	6,483	5,577	5,319	5,252	4,887

W Withheld to avoid disclosing individual company confidential data; included in total.
[1] Includes Arizona 1968–69, Arkansas 1968–72, Idaho 1968–72, New Mexico 1968–72, South Dakota 1970, and 1972.

containing slags was not included in the recovered vanadium pentoxide figures shown in tables 1 and 4.

Most of the vanadium obtained from domestic uranium-vanadium ores in 1972 was recovered at the Rifle mill of Union Carbide Corp. The Soda Springs, Idaho, plant of Kerr-McGee Corp. and the Hot Springs, Ark., plant of Union Carbide Corp. recovered vanadium from byproduct ferrophosphorus obtained in elemental phosphorus production. The Hot Springs, Ark., plant also recovered vanadium from Arkansas vanadium ore. Other producers of vanadium pentoxide or ammonium metavanadate from domestic ores and/or residues included the Edgemont, S. Dak., mill of Susquehanna-Western, Inc., the Wilmington, Del., plant of The Pyrites Co., Inc., the Texas City, Tex., plant of Gulf Chemical & Metallurgical Corp., and the Moab, Utah, mill of Atlas Corp.

Union Carbide shut down its mine and milling operations at Rifle, Colo., on August 1 and began transferring its vanadium milling circuit to Uravan. It was estimated that installation of the circuit at Uravan would take about 9 to 10 months, and meanwhile the Rifle mill will be maintained on a standby status. Vanadium liquor produced at the new Uravan operation will be shipped to Rifle where ammonium metavanadate will be precipitated, vanadium oxide produced, and the product stored for shipment. Management cited the following reasons for the shutdown and transfer: the depressed uranium prices caused by delay in nuclear powerplant construction, the diminished ore reserves and relatively low ore grades, and the increased cost caused by meeting new regulations concerning radon daughter exposure in underground mines.

Atlas Corp. began preparations to resume production of vanadium from Colorado Plateau ores. Its plans included the reinstallation of a vanadium recovery circuit at its Moab mill. However, the circuit will not be entirely completed until late 1975 or early 1976. Ongoing exploration has revealed a large deposit of uranium-vanadium ore worth an estimated $30 to $50 million located on leased properties in the Sage Plains area of Utah. In addition, the company signed an agreement to buy all the American Metals Climax (AMAX) uranium-vanadium properties in the Uravan minerals belt of Utah and Colorado, estimated to be worth another $30 to $50 million, and finalized the sale in early 1973. The company expects to be in a strong position to process ores on a toll basis and to bid for uranium-vanadium ore reserves.

Table 3.—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]
1968	7,105	6,483
1969	5,737	5,577
1970	5,793	5,319
1971	5,547	5,252
1972	4,699	4,887

[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 4.—Production of vanadium pentoxide in the United States [1]

(Short tons)

Year	Gross weight	V_2O_5 content
1968	12,105	10,976
1969	12,120	10,542
1970	11,035	9,986
1971	10,492	9,448
1972	10,410	9,367

[1] Includes vanadium pentoxide and metavanadate produced directly from all domestic sources, plus small byproduct quantities from imported chromium ores.

The Pyrites Co., a subsidiary of Rio Tinto-Zinc Corp., Ltd., placed its new vanadium facility at Wilmington, Del., in partial operation, and was producing ammonium metavanadate by the end of the year. Plans called for production of fused flake vanadium pentoxide later; feed is expected to consist largely of residues.

CONSUMPTION AND USES

Total domestic consumption of vanadium, as reported for all end-use categories in table 6, rose almost 9% in 1972. The marked increase in consumption in alloy steels and the decrease in consumption in carbon steel reflected a change in reporting. The old category for alloy steel (excluding stainless and tool) was subdivided into the following new categories: full alloy steel, high-strength low-alloy steel, and electric steel (special steel for use in electrical equipment). Under the revised reporting, some material that formerly appeared in the categories for carbon steel or miscellaneous and unspecified now appears in the new alloy steel categories.

Union Carbide Corp. announced a new steel additive, trademarked Nitrovan, containing 78% to 80% Vanadium, 6% to 7% nitrogen, and 10% to 12% carbon. It was designed for use in vanadium-nitrogen high-strength steels, especially the "killed" grades. Nitrovan was said to have the advantages of dissolving quickly and mixing uniformly in the steel, and having a higher purity than the premium grades of ferrovanadium.

Table 5.—Consumption and consumer stocks of vanadium materials in the United States
(Short tons of contained vanadium)

Type of material	1971		1972	
	Consumption	Ending stocks	Consumption	Ending stocks
Ferrovanadium [1]	4,171	544	4,493	623
Oxide	143	24	189	56
Ammonium metavanadate	35	9	47	8
Other [2]	453	68	498	101
Total	4,802	645	5,227	788

[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 6.—Consumption of vanadium in the United States by end use
(Short tons of contained vanadium)

End use	1972
Steel:	
Carbon	630
Stainless and heat resisting	30
Full alloy	1,088
High-strength low-alloy	2,062
Electric	W
Tool	620
Cast irons	60
Superalloys	17
Alloys (excludes steels and superalloys):	
Cutting and wear resistant materials	W
Welding and alloy hard-facing rods and materials	11
Nonferrous alloys	353
Other alloys [1]	20
Chemical and ceramic uses:	
Catalysts	147
Other [2]	W
Miscellaneous and unspecified	189
Total	5,227

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 reported in table 5, producers' stocks of vanadium as fused oxide, precipitated oxide, metavanadate, metal, alloys, and chemicals totaled 3,640 short tons of contained vanadium at yearend 1972, compared with 3,775 tons at yearend 1971.

PRICES

The dealer price quoted by Metals Week for export merchant technical-grade vanadium pentoxide remained at the late 1971 level of $1.50 per pound of contained V_2O_5 throughout the whole of 1972. The quote for domestic 98% fused vanadium pentoxide, applying to metallurgical markets, also was unchanged at $1.50 per pound of contained V_2O_5. The price for technical-grade, air-dried vanadium pentoxide, used by the chemical industry, stayed at $2.21 per pound of contained V_2O_5, f.o.b. plant, from 1971 through the end of 1972.

GSA sold all its excess vanadium pentoxide in May for bids ranging between $1.14 and $1.18 per pound of contained vanadium pentoxide.

There were small changes in some of the ferrovanadium prices in 1972. The price for U.S. standard grade ferrovanadium was $4.12 per pound of contained vanadium f.o.b. shipping point until July 1, when it rose to $4.19 for the rest of the year. On July 1 the price of Carvan also rose, in this instance from the $3.48 per pound of contained vanadium that existed since 1971 to the $3.66 that continued through the end of 1972. The price for Ferovan remained unchanged during 1972 at $3.68 per pound of contained vanadium.

FOREIGN TRADE

During 1972 exports of both ferrovanadium and vanadium ores, concentrates, and oxides varied irregularly from month to month, usually at a low level. The declared value for exports of ores, concentrates, and technical-grade oxides averaged

Table 7.—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)			
	1971		1972		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Argentina	9	30	--	--	--	--	--	--
Australia	5	13	--	--	--	--	--	--
Austria	--	--	--	--	127	360	101	216
Belgium-Luxembourg	--	--	74	129	--	--	--	--
Brazil	8	23	--	--	20	49	--	--
Canada	450	1,178	221	596	48	217	--	--
Chile	2	5	--	--	16	21	--	--
Colombia	--	--	2	5	--	--	--	--
Czechoslovakia	--	--	--	--	121	633	--	--
Dominican Republic	(1)	1	--	--	--	--	--	--
France	80	234	--	--	12	29	(1)	1
Germany, West	9	12	--	--	2	6	117	247
India	172	493	18	34	57	208	--	--
Israel	4	9	--	--	--	--	--	--
Italy	--	--	--	--	27	88	--	--
Japan	312	772	29	57	29	86	--	--
Korea, Republic of	6	9	--	--	--	--	--	--
Mexico	137	300	95	231	24	50	31	73
Netherlands	132	391	--	--	--	--	--	--
Spain	--	--	17	42	--	--	--	--
Switzerland	25	20	81	162	--	--	102	219
United Kingdom	--	--	--	--	37	87	--	--
Total	1,351	3,490	537	1,256	520	1,834	351	756

[1] Less than ½ unit.

Table 8.—U.S. imports of ferrovanadium, by country
(Thousand pounds and thousand dollars)

Country	1971			1972		
	Gross weight	Vanadium content	Value	Gross weight	Vanadium content	Value
General imports:						
Austria	--	--	--	255	207	648
Belgium-Luxembourg	--	--	--	44	36	113
Canada	--	--	--	14	11	38
Germany, West	177	137	439	549	411	1,194
Norway	--	--	--	140	67	197
Sweden	--	--	--	68	55	164
Switzerland	--	--	--	85	50	151
Total	177	137	439	1,155	837	2,505
Imports for consumption:						
Austria	--	--	--	255	207	648
Belgium-Luxembourg	--	--	--	44	36	113
Canada	--	--	--	14	11	38
Germany, West	138	110	360	386	282	817
Norway	--	--	--	56	26	76
Sweden	--	--	--	68	55	164
Switzerland	--	--	--	85	50	151
Total	138	110	360	908	667	2,007

$1.21 per pound of contained vanadium pentoxide in 1972, compared with $1.98 in 1971. The declared value for exports of ferrovanadium averaged $2.34 per pound of alloy, compared with $2.58 in 1971.

No imports classified as vanadium ore and concentrate were received in 1972. Imports of vanadium-bearing materials such as ashes and slags, which are classified as metal-bearing residues, were estimated to be about 2.8 million pounds of contained vanadium in 1972, compared with 4.0 million pounds in 1971. Most of these materials originated in the Republic of South Africa and Chile.

WORLD REVIEW

Besides those listed in table 9, several other nations produced relatively minor amounts of vanadium, usually from secondary, waste, or byproduct sources. Japan and Canada both produced vanadium from several such sources, as did West Germany. While the world market for vanadium was not strong in 1972, it was better than in 1971.

Australia.—The Julia Creek, Queensland, vanadiferous oil shale project was expected to be set back because of technical problems relating to vanadium extraction. A special research program to solve these problems was anticipated to take at least 2 years. The project is a joint venture of the Oil Shale Corp., Australian Aquitaine Petroleum, and Pacminex Pty.[2]

Ferrovanadium Corp. N.L. announced the discovery of gold in its vanadium-bearing titanomagnetite-titanomartite ore body. Later in the year, it announced that it had commissioned a leading engineering group to make a feasibility study of the deposit.

Finland.—Rautaruukki Oy, Finland's vanadium producer, revealed plans for opening a new mine and vanadium pentoxide operation at Mustavaara, 125 miles north of their present source of vanadium at Otanmäki. The operation was designed to produce about 1,850 short tons of contained vanadium annually from 1.76 million tons of ore. The deposit was estimated to contain 44 million tons of ore, and is to be mined as an open pit.

France.—According to French trade statistics, France imported 855 short tons of vanadium pentoxide (not including other vanadium oxides) in 1971, of which 476 tons came from Finland, 171 tons from West Germany, 138 tons from the Netherlands, and the balance from other sources. The camparable import figure for 1970 was 1,483 short tons, of which 622 tons came from West Germany, 410 tons from

[2] Metal Bulletin (London). Julia Creek Setback. No. 5729, Sept. 1, 1972, p. 18.

Finland, 396 tons from the Netherlands, and the balance from other sources.

Germany, West.—According to the trade statistics of West Germany, imports of vanadium-bearing slags and residues totaled 33,800 short tons (gross weight) in 1972, 5,720 tons of this from Belgium-Luxembourg, 1,835 tons from France, 1,050 tons from the Soviet Union, 415 tons from other European and Israeli sources, and the balance from unspecified sources. For comparison, the imports of vanadium-bearing slags and residues totaled 24,240 short tons in 1971, 3,800 tons of this from Belgium-Luxembourg, 1,350 tons from France, 840 tons from other European and Israeli sources, and the balance from unspecified sources.

Luxembourg.—Continental Alloys began installing slag roasting facilities at its works at Dommeldange and hoped to begin operation some time during 1973. The plant was designed to have a capacity of about 2,000 tons of fused flake vanadium pentoxide product per year, and to consume South African vanadiferous slag barged to the plant by way of the inland waterway system. Already existing facilities at the same location will convert the fused flake product into ferrovanadium.[3]

Mozambique.—The Cia. do Urânio de Moçambique has submitted a feasibility study for a vanadium slag-producing iron and steel works to the Portuguese Government. The proposed plant would be built in the Tete district by mid-1975 and would use local vanadium-bearing titanomagnetite ore and coal, while electricity would come from the Cabora Bassa power complex now under construction. The process route would involve electric reduction and LD steelmaking.[4]

South Africa, Republic of.—The vanadium-bearing slag output of Highveld Steel and Vanadium Corp., Ltd., totaled 31,072 short tons in the fiscal year ending June 30, 1972, compared to 31,736 short tons in the previous fiscal year. Although the gross weight declined, the actual output of vanadium pentoxide in the slag was the highest to date because of an increase in the proportion of vanadium in the iron. The problem with electrode failure in the iron furnaces was solved, so that the plant was able to operate at 95% of rated capacity after the end of February. The fifth prereduction kiln was commissioned on schedule in February 1972.

The company's Vantra Division produced vanadium pentoxide at a substantially lower rate in this fiscal year than last year because of the poor market for vanadium. Because of this reduced production, the Vantra Division began using ore from the Mapochs mine in April 1972, resulting in the temporary closure of the Kennedy's Vale mine and in the indefinite postponement of operations in the new Northam mine.

United Kingdom.—Imports of ferrovanadium were 197 tons (gross weight) in 1971, with 137 tons coming from Austria

[3] Metal Bulletin (London). New Continental Alloys Roaster. No. 5723, Aug. 8, 1972, p. 13.
[4] Metal Bulletin (London). Mozambique Steelworks Planned. No. 5671, Feb. 1, 1972, p. 27.

Table 9.—Vanadium: World production from ores and concentrates, by country

(Short tons of contained vanadium)

Country	1970	1971	1972 p
Chile e	610	660	720
Finland (in vanadium pentoxide product)	1,450	1,222	1,312
France e 1	100	100	100
Norway e	1,190	1,160	1,200
South Africa, Republic of:			
Content of pentoxide and vanadate products	2,665	e 2,470	e 3,370
Content of vanadiferous slag product e	r 4,800	r 4,060	4,860
Total	7,465	6,530	8,230
South-West Africa, Territory of: (in lead-vanadate concentrate) e	660	730	600
U.S.S.R. (in slag exports) 2	3,377	2,917	e 2,900
United States (recoverable vanadium)	5,319	5,252	4,887
Total	r 20,171	r 18,571	19,949

e Estimate. p Preliminary. r Revised.
1 Byproduct from bauxite.
2 Partial figure representing only that vanadium contained in exported slags; does not include vanadium produced for domestic consumption in any form or for export in any form except slag.

and the balance from three other sources. These imports were only a fraction of the 1970 total of 1,308 tons, 524 tons of which came from Austria, 216 tons from Norway, 195 tons from Sweden, and the balance from six other sources.

TECHNOLOGY

As in the last several years, much of the research on vanadium in 1972 centered on vanadium metal as a possible structural material for fast-breeder reactors, and on vanadium extraction from raw materials. There was an investigation of the purification of vanadium metal by an electrotransport technique. A pair of studies were made which have implications concerning the strength of vanadium metal, specifically concerning allotropy in vanadium and deformation mechanisms of vanadium. Three investigations were reported concerning carbon, nitrogen, and oxygen impurities in vanadium metal, and two interesting new processes for extracting vanadium were patented.

Electrotransport was demonstrated to be an effective method of reducing interstitial impurities in vanadium metal to a total amount less than 5 weight ppm.[5] The technique of electrotransport involves heating a cylindrical rod by internal electrical resistance to cause migration of the impurities towards the cathode end upon application of a high density electric current.

Both polycrystalline and single crystal vanadium metal were strained in tension at low temperatures, varying both the strain and the temperature, to study the deformation mechanism. A change of rate-controlling mechanism occurred at approximately 200 K. The predominant controlling mechanism seemed to be the interaction between dislocations and interstitial impurities at temperatures between 200 and 293 K. Single crystals developed mechanical twins when deformed at 77 and 120 K.[6]

The possibility of allotropy in vanadium at subambient temperatures was investigated by measuring electrical resistivity and elastic constants, and by X-ray diffractometry. While some previous workers have proposed a low-temperature allotropic form on the basis of anomalies in various properties, no evidence of allotropy was found in the temperature range 77 to 300 K.[7]

Using transmission electron microscopy on thin foils doped with carbon, the precipitation of carbon from a supersaturated solid solution in vanadium was investigated. It was found to precipitate initially as a finely dispersed carbide which became coarser with age.[8] The precipitation rate must largely depend on the rate of carbon diffusion.[9]

Other investigations disclosed that the precipation of $V_{16}N$ occurs homogeneously in vanadium-nitrogen alloys but requires long-range diffusion of nitrogen,[10] and, contrary to the conclusions of some investigators, the scavenging action of titanium for oxygen in vanadium-titanium alloys is apparently not a function of titanium concentration.[11]

One of the new processes patented in 1972 involved the extraction of vanadium from calcium-containing vanadium ore. Vanadium can be extracted from high-calcium ores and oil shales by slurrying the calcined ore in highly alkaline water, treating the slurry with carbon monoxide to precipitate waste calcium carbonate, contacting the vanadium-enriched solution with a basic anion exchange resin, and then stripping the adsorbed vanadium from the resin with a sodium chloride solution.[12] Another patent provided for

[5] Carlson, O. N., F. A. Schmidt, and D. G. Alexander. Electrotransport Purification and Some Characterization Studies of Vanadium Metal. Met. Trans., v. 3, No. 5, May 1972, pp. 1249–1254.

[6] Wang, C. T., and D. W. Bainbridge. The Deformation Mechanism for High-Purity Vanadium at Low Temperatures. Met. Trans., v. 3, No. 12, December 1972, pp. 3161–3165.

[7] Westlake, D. G., S. T. Ockers, M. H. Mueller, and K. D. Anderson. Reexamination of Vanadium for Allotropy. Met. Trans., v. 3, No. 7, July 1972, pp. 1711–1713.

[8] Diercks, D. R. and C. A. Wert. An Electron Microscopy Study of Carbide Precipitation in Vanadium. Met. Trans., v. 3, No. 7, July 1972, pp. 1699–1708.

[9] Mosher, D. R., D. R. Diercks, and C. A. Wert. Precipitation of Carbon from Solid Solution in Vanadium. Met. Trans., v. 3, No. 12, December 1972, pp. 3077–3080.

[10] Potter, D. and C. Altstetter. Precipitation of $V_{16}N$ in Vanadium. Materials Sci. and Eng., v. 9, No. 1, January 1972, pp. 43–46.

[11] Hasson, D. F. and R. J. Arsenault. Scavenging in Vanadium-Titanium Alloys. J. Less-Common Metals, v. 27, No. 3, June 1972, pp. 417–418.

[12] Hass, F. C. (assigned to Oil Shale Corp.). Vanadium Recovery Process. U.S. Pat. 3,656,936, Apr. 18, 1972.

vanadium recovery from ore leach solutions or other aqueous acidic solutions by contacting the solution with a specified fluorinated beta-diketone dissolved in kerosene or isooctane, and then stripping the vanadium-rich organic phase with a strong mineral acid.[13]

[13] Lucid, M. F. (assigned to Kerr-McGee Corp.). Extraction of Vanadium and Copper with Fluorinated Beta-Diketones. U.S. Pat. 3,700,416, Oct. 24, 1972.

Vermiculite

By Frank B. Fulkerson [1]

Crude vermiculite production increased 12% in 1972. The vermiculite was shipped from Montana and South Carolina mines to processing plants in 31 States for exfoliation. Apparent consumption of exfoliated vermiculite increased 18%. The exfoliated material was used mainly as lightweight concrete aggregate, as loose fill insulation, and in horticulture. Output of crude vermiculite in the Republic of South Africa, the only other significant world producer, advanced 12%.

Table 1.—Salient vermiculite statistics

	1968	1969	1970	1971	1972
United States:					
Sold and used by producers:					
Crude____thousand short tons__	290	310	285	301	337
Value____thousand dollars__	$5,684	$6,805	$6,501	$7,198	$8,092
Average value per ton____	$19.60	$21.95	$22.81	$23.91	$24.01
Exfoliated____thousand short tons__	213	250	221	209	247
Value____thousand dollars__	$16,845	$19,916	$18,809	$20,885	$24,777
Average value per ton____	$79.08	$79.66	$85.11	$99.93	$100.31
World: Production, crude____thousand short tons__	421	466	431	459	512

DOMESTIC PRODUCTION

Crude Vermiculite.—The quantity of crude vermiculite sold or used by producers increased from 301,000 tons in 1971 to 337,000 tons in 1972. The principal producer was the Construction Products Division, W. R. Grace & Co., which operated mines near Libby, Mont., and Enoree, S.C. The only other producer was Patterson Vermiculite Co., Lanford, S.C.

W. R. Grace & Co., continued construction on a $7 million, 1,000-ton-per-day wet-processing plant near Libby. The new facility, scheduled to be completed in mid-1973, was being equipped to process finer sized ores.

Exfoliated Vermiculite.—The tonnage of exfoliated vermiculite sold or used by producers increased from 209,000 in 1971 to 247,000 in 1972. The lightweight material was produced at 50 plants in 31 States. Leading producer was W. R. Grace & Co., which operated 26 plants in 22 States. Leading States were California, Florida, New Jersey, South Carolina, and Texas. About 42% of the exfoliated vermiculite was produced in the five States.

CONSUMPTION AND USES

Lightweight concrete aggregate, loose fill insulation, and horticulture were the principal markets for exfoliated vermiculite. The quantity used as lightweight concrete aggregate increased from 74,400 tons in 1971 to 80,000 tons in 1972, and the quantity consumed as loose fill insulation advanced from 71,200 tons to 74,000 tons. The tonnage consumed in horticulture increased from 28,000 to 40,000.

By main categories, the end-use pattern was as follows: Aggregates (concrete, plas-

[1] Industry economist, Division of Nonmetallic Minerals.

ter, cement), 42%; insulation (loose fill, block, pipe covering, packing), 34%; agriculture (horticulture, soil conditioning, fertilizer carrier, litter), 21%; and miscellaneous, 3%.

PRICES

The Engineering and Mining Journal quoted yearend prices for crude vermiculite as follows: Per short ton, f.o.b. mine, Montana and South Carolina, $25 to $38; and c.i.f. Atlantic ports, Republic of South Africa ore, $35 to $49.

The average value of crude vermiculite, screened and cleaned, at the mine, was $24.01 per short ton, compared with $23.91 in 1971. The average value of exfoliated vermiculite was $100.31 per short ton, compared with $99.93 in 1971.

FOREIGN TRADE

Quantities of crude vermiculite were exported to Canada and other countries, but tonnage figures were not available. The Republic of South Africa was the only important source of vermiculite imports. The crude vermiculite was imported duty free into the United States.

WORLD REVIEW

The United States and the Republic of South Africa produced nearly all the vermiculite used in the free world. Some vermiculite was probably produced in the U.S.S.R., but data were not available.

Early in 1972 Palabora Mining Co. completed the expansion and modernization of its dry-processing plant in northeastern Transvaal, Republic of South Africa. Mill capacity was increased from 140,000 tons per year to 175,000. Total cost of the mill modifications, including a dust collection system, was $3.5 million. The new plant gave the company the capability to process finer sized ore grades. This increased available ore reserves 50%. Demand for the finer sizes was increasing. Palabora produced a record 163,000 short tons of crude vermiculite in 1972. The year's output was about 17,000 tons higher than that of 1971. Most of the vermiculite was exported to Europe; some was also shipped to North America, Oceania and the Far East. A new subsidiary, Micronized Products, Ltd., was formed to market exfoliated vermiculite in the filter-aid and related fields.

Table 2.—Vermiculite: Free world production by country

(Short tons)

Country	1970	1971	1972 p
Argentina	r 4,318	4,727	e 4,750
Brazil	4,674	e 5,000	e 5,000
India	801	592	1,474
Kenya	1,839	1,498	1,027
South Africa, Republic of	134,367	145,582	163,035
Tanzania	165	--	--
United States (sold or used by producers)	285,331	301,483	336,798
Total	431,495	458,882	512,084

e Estimate. p Preliminary. r Revised.

Table 3.—Republic of South Africa: Exports of vermiculite, by country

(Short tons)

Country	1970	1971	1972
Australia	3,276	4,616	NA
Belgium	1,247	917	
Canada	7,147	6,926	
Finland	884	917	
France	11,736	12,771	
Germany, West	14,926	13,176	
Ireland	1,443	1,442	
Italy	21,196	23,186	
Japan	9,634	9,820	
Netherlands	958	1,251	
New Zealand	--	668	
Spain	4,787	4,231	
Sweden	2,865	2,294	
Switzerland	765	947	
United Kingdom	31,970	31,975	
United States	12,083	18,130	
Undisclosed	2,695	3,023	
Total	127,612	136,290	142,127
Total value [1]	$3,150,288	$3,147,050	$3,715,223
Average value per ton [1]	$24.69	$23.09	$26.14

NA Not available.
[1] Converted to U S. currency at the rate of 1 rand equals U.S. $1.40.

TECHNOLOGY

A patent was issued on the use of exfoliated vermiculite in the thermal insulation of a steam injection well. The annular space between two strings of casing in the well is filled with a slurry of exfoliated vermiculite.[2]

A process was patented for the use of vermiculite in waste water treatment. Vermiculite ore is chemically exfoliated with aqueous n-butylammonium chloride, sodium chloride, or lithium chloride to produce a bulk material having enhanced absorptive and coagulative properties for removing contaminants from waste water.[3]

A patent on the use of vermiculite to remove oil spills from the surface of oceans, lakes, and rivers was issued. To remove the oil from the water surface, a wicking composition consisting of asphalt-treated or otherwise hydrophobized exfoliated vermiculite is spread on the water, the oil is absorbed in the wicking material, and the loaded material is burned.[4]

An improved production method for exfoliating vermiculite and simultaneously incorporating fertilizer values into the exfoliated material was patented. The ore is preheated in a saturated atmosphere to maintain its water content prior to thermal expansion, and the preheated ore is mixed with a molten mass of the fertilizer salts. The ore is exfoliated by the heat of the molten mass, resulting in a semisolid, very pliable and workable mass. The mass is cooled, and the cooled material is ground.[5]

A West German patent was granted on the preparation of exfoliated vermiculite having ion-exchange properties, high water absorption, and good insulation characteristics. Sized crude ore is exfoliated by irradiation with electromagnetic waves. Preferably, the ore is activated before heating by incorporating added cations such as nitrogen, sulfur, or oxygen.[6]

---

[2] Burnside, F. D. (assigned to Shell Oil Co.). Thermal Insulation of Wells. U.S. Pat. 3,650,327, Mar. 21, 1972.

[3] Patil, A. S., J. W. Icraus, and J. Block. Vermiculite Use for Waste Water Renovation. U.S. Pat. 3,677,939, July 18, 1972.

[4] McGuire, R. G., E. Mitchell, and J. D. Pellegrini, Jr. (assigned to Gulf Research & Development Co.). Method of Removing Oil From the Surface of Water and Composition Therefor. U.S. Pat. 3,696,051, Oct. 3, 1972.

[5] Robinson, D. W. (assigned to W. R. Grace and Co.). Thermally Expanding Vermiculite and Other Thermally Expandable Materials, Utilizing Said Materials as Carrier. U.S. Pat. 3,686,134, Aug. 22, 1972.

[6] Wada, T. (assigned to Takeda Chemical Industries, Ltd., Osaka, Japan). Preparation of Exfoliated Vermiculite Having Ion-Exchange Properties. German Pat. 2,134,516, Jan. 20, 1972.

Table 4.—Vermiculite exfoliating plants in the United States in 1972

Company	State	County	Nearest city or town
Arizonolite Co	Arizona	Maricopa	Phoenix.
Carolina Wholesale Florist Co	North Carolina	Lee	Sanford.
Cleveland Builders Supply Co	Ohio	Cuyahoga	Cleveland.
Construction Products Division, W. R. Grace & Co	Arkansas	Pulaski	North Little Rock.
	California	Alameda	Newark.
		Los Angeles	Los Angeles.
	Colorado	Denver	Denver.
	Florida	Broward	Pompano Beach.
		Duval	Jacksonville.
		Hillsborough	Tampa.
	Illinois	Cook	Franklin Park.
	Kentucky	Campbell	Wilder.
	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.
	Oregon	Multnomah	Portland.
	Pennsylvania	Lawrence	Elwood City.
	South Carolina	Greenville	Travelers Rest.
		Laurens	Enoree.
	Tennessee	Davidson	Nashville.
	Washington	Spokane	Spokane.
	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.
McArthur Co	Minnesota	Ramsey	St. Paul.
Mica Pellets, Inc	Illinois	De Kalb	De Kalb.
B. F. Nelson Manufacturing Co	Minnesota	Hennepin	Minneapolis.
Patterson Vermiculite Co	South Carolina	Laurens	Lanford.
Robinson Insulation Co	Montana	Cascade	Great Falls.
	North Dakota	Ward	Minot.
The Schundler Co	New Jersey	Middlesex	Metuchen.
Southwest Vermiculite Co	New Mexico	Bernalillo	Albuquerque.
Strong-Lite Products	Arkansas	Jefferson	Pine Bluff.
Supreme Perlite Co	Oregon	Multnomah	Portland.
Texas Vermiculite Co	Oklahoma	Oklahoma	Oklahoma City.
	Texas	Bexar	San Antonio.
		Dallas	Dallas.
Vermiculite of Hawaii, Inc	Hawaii	Honolulu	Honolulu.
Vermiculite Industrial Corp	Pennsylvania	Allegheny	Pittsburgh.
Vermiculite-Intermountain, Inc	Utah	Salt Lake	Salt Lake.
Vermiculite Products, Inc	Texas	Harris	Houston.

Zinc

By Albert D. McMahon,[1] John M. Hague,[2] and Herbert R. Babitzke [1]

The producing segments of the domestic zinc industry operated at low levels in 1972, but the use of zinc almost reached the record high of 1966. A large number of small and intermittent producing mines active in 1971 were idle in 1972, and several significant operations closed, which resulted in an annual production loss of 24,000 short tons. The number of mines reporting zinc production to the Bureau of Mines declined from 214 in 1970 to 142 in 1971 and 68 in 1972. The new zinc-copper mine in Maine, byproduct zinc from the Brushy Creek mine in Missouri, and the coming expansion of the Balmat mine in New York should reverse the decline in U.S. mine production of recent years. The closure of a slab-zinc-producing plant, the largest electrolytic zinc refinery in the United States, a 17% drop in zinc concentrate imports and decreased mine production were the principal reasons for the 140,000 ton decline in smelter production during 1972. This loss of supply was partially replaced by releases of slab zinc from the national stockpile authorized by Public Law 92–283. Substantial increases in demand for most all use categories were in response to greater industrial activity in 1972. The automotive, construction, and appliance industries, the major consumers of zinc for diecastings, galvanizing, and brass and bronze products all improved over 1971. Demand followed the seasonal pattern, increasing each month to a high in May, receding during the vacation months of June and July, rising again to a peak for the year in October, then declining for the last 2 months. Record quantities were used: Galvanizing reached a record high; 1972 was the third largest year for zinc diecastings; and for brass products, 1972 was surpassed only by the World War II years, 1941 through 1945.

General Services Administration (GSA) sales of zinc during the first 3 months of 1972 depleted the balance authorized under Public Law 89–322. New legislation for the release of an additional 515,200 tons became law in the latter part of April after negotiations between GSA and primary producers developed an agreeable disposal plan. Approximately 190,000 tons were committed from May through December. Revisions of the disposal plan will allow depletion of the balance by the end of the first quarter of 1974.

Total imports (zinc in concentrates plus metal) increased to 777,500 tons, 17% higher than those of 1971: The zinc content of imported concentrates declined 26% and imports of metal totaling 522,600 tons were up 64%.

Throughout 1972 the price of domestically produced Prime Western zinc was controlled by the Price Commission. It allowed increases of 1 cent and 1/2 cent per pound in April–May and December respectively, raising the ceiling price to 18.5 cents per pound. Foreign zinc sold in the United States commanded at least a 1 cent premium as Australian, Canadian, Mexican, and Peruvian producers increased the price of their zinc in the United States some time prior to the raises allowed U.S. producers by the Price Commission.

Legislation and Government Programs.—The GSA sold 20,580 tons of zinc during the first quarter of 1972. This zinc was all that remained under the authorization of Public Law 89–322 enacted November 4, 1965, for disposal of 200,000 tons of zinc from the national stockpile. On April 26, 1972, the President signed Public Law 92–283 authorizing release of approximately 515,000 short tons of zinc over a period of years of which 440,000 tons was to be released through primary domestic producers and 75,000 tons was for sale by

[1] Physical scientist, Division of Nonferrous Metals.

[2] Mining engineer, Division of Nonferrous Metals.

GSA on an off-the-shelf basis. This zinc was in excess to stockpile requirements, and all zinc released was for domestic consumption only. The inventory up to objective is 560,000 tons. Sales under Public Law 92–283 through December 31, 1972, were 190,668 tons: 128,450 tons to primary domestic producers and 62,218 tons as shelf item sales. As a result of the rapid drawdown of the 75,000 tons off-the-shelf zinc, release under the program was temporarily suspended on December 18, 1972, and a revised program was issued January 15, 1973. The revised program offered 6,400 tons of zinc each calendar quarter through June 1973, followed by 6,250 tons per quarter as long as zinc remained available for sale to domestic primary producers under their long-term agreements with GSA. The set-aside program was revised upward effective July 1, 1973, to allow releases of 25,000 tons of zinc to domestic consumers per quarter and at the same time allowing producers to draw more zinc from the stockpile. On December 31, 1972, approximately 313,552 tons of zinc remained to be released through primary domestic producers, and 12,782 tons remained from the original 75,000 tons set-aside for off-the-shelf sales. No transfers of zinc to Government agencies were made in 1972, leaving a balance of 22,097 tons of the 50,000 tons approved in Public Law 89–9 passed April 2, 1965.

During the year producers remelted 75,840 tons of GSA zinc, and 37,806 tons was purchased for direct shipment to customers without altering its form, an additional 62,218 tons was released off-the-shelf directly from GSA to consumers, and 20,580 tons was sold under Public Law 89–322 resulting in a total of 196,444 tons. However, the GSA stockpile report to the Congress shows a decrease of 188,354 tons in the physical inventory of zinc during the year which reflects nondelivery of some orders, therefore it may be concluded that 188,354 tons of stockpile zinc entered the zinc supply during 1972.

The President's economic stabilization program, which entered Phase 2 November 12, 1971, continued through 1972. The program made it mandatory for domestic zinc producers to justify to the Price Commission price increases in their products. A criteria of cost justification and a profit

Table 1.—Salient zinc statistics

	1968	1969	1970	1971	1972
United States:					
Production:					
Domestic ores, recoverable content short tons	529,446	553,124	534,136	502,543	478,318
Value thousands	$142,950	$161,512	$163,650	$161,819	$169,803
Slab zinc:					
From domestic ores short tons	499,491	458,754	403,953	403,750	400,969
From foreign ores do	521,400	581,843	473,858	362,683	232,211
From scrap do	79,865	70,553	77,156	80,923	73,718
Total do	1,100,756	1,111,150	954,967	847,356	706,898
Secondary zinc [1] do	276,092	307,714	264,074	r 279,399	298,773
Exports of slab zinc do	33,011	9,298	288	13,346	4,324
Imports (general):					
Ores (zinc content) do	543,366	602,120	525,759	342,521	254,868
Slab zinc do	304,576	324,776	270,413	319,568	522,612
Stocks, December 31:					
At producer plants do	65,379	65,788	98,314	r 41,220	21,181
At consumer plants do	101,818	102,007	92,674	91,523	126,141
Government stockpile do	1,160,606	1,142,185	1,141,490	1,137,937	949,583
Consumption:					
Slab zinc do	1,350,656	1,385,380	1,186,951	1,254,059	1,418,349
All classes do	1,745,357	1,814,167	1,571,596	1,650,694	1,828,753
Price: Prime Western [2] cents per pound	13.50	14.65	15.32	16.13	17.75
World:					
Production:					
Mine short tons	5,483,540	5,888,298	6,023,488	6,155,074	6,157,623
Smelter do	5,100,953	5,482,489	5,320,771	5,175,426	5,615,403
Price: Prime Western grade, London cents per pound	11.89	12.96	13.36	14.08	17.13

r Revised.
[1] Excludes redistilled slab zinc.
[2] 1968–1970, East St. Louis price; 1971–72 delivered price.

margin test was used to determine if a price increase was warranted.

The International Lead and Zinc Study Group held its 16th annual meeting in Geneva, Switzerland, November 16, 1972. Meetings of various committees and subcommittees were held before and during the session. The 1972 forecasts made at the 15th annual meeting for world zinc mine and metal production were reduced to estimates of 4,810,000 short tons and 4,540,000 tons, respectively. The zinc metal consumption forecast was increased to an estimated 4,788,000 tons. Forecasts for 1973 showed substantial increases in mine and metal consumption. Other topics discussed were research and development, long-term projections, consumption trends, trade liberalization, new mine and smelter projects, and scrap.

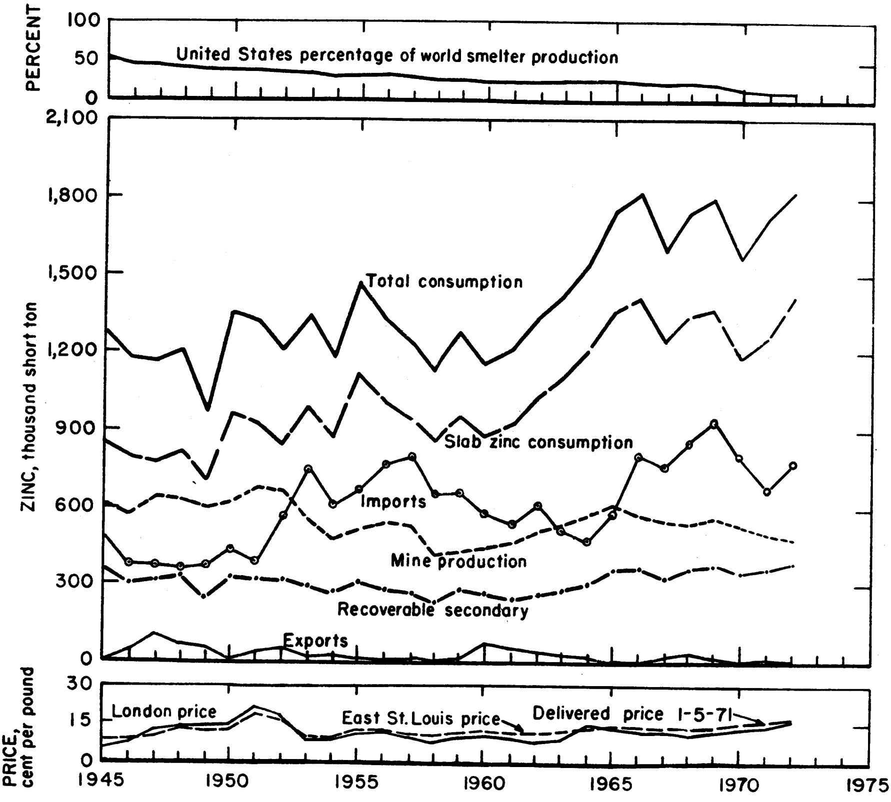

Figure 1.—Trends in the zinc industry in the United States.

DOMESTIC PRODUCTION

MINE PRODUCTION

Mine production of recoverable zinc in the United States declined 5% in 1972 to 478,318 tons, the lowest annual output since 1961. Production was reported in 18 States. Five States recorded increases over 1971, and 13 States recorded decreases. Tennessee led the Nation in zinc production for the 15th consecutive year with 101,722 short tons, 15% below that of 1971. Colorado ranked second with a 4% increase, Missouri ranked third with a 28% increase, and New York ranked fourth with a 4% decrease from 1971. Nevada mine production dropped to zero and Montana dropped to 12 tons for 1972. The States east of the Mississippi River accounted for 55% of the U.S. 1972 mine production.

Sources of zinc production for 1972 are

shown in table 4 according to the principal metal or combination of metals extracted. The percentage distribution is as follows: Zinc ore, 57%; zinc-lead ores, 21%; lead ores, 14%; copper-zinc and copper-lead-zinc ores, 6%; and from all other sources, 2%. Less high grade zinc ore was mined in 1972, but there was a net increase in the zinc content over that of 1971. The average zinc content of the 6.5 million tons of zinc ore mined in 1972 was 4.23% (274,440 tons of zinc) compared with 6.8 million tons of ore averaging 3.74% zinc (256,247 tons of zinc) in 1971.

The 25 leading mines listed in table 5 accounted for 89% of the domestic recoverable mine production. The five leading mines produced 36%, and the first 10 mined 56%.

Tennessee maintained its rank as the leading producing State in 1972. Production from mines of the American Smelting & Refining Co. (ASARCO) continued as planned in 1972 and amounted to 75,200 tons of zinc. The Coy mine, the smallest of the four operating units, was shutdown in August to start a development program that will increase production capacity.[3] The Mascot mill, which has operated since 1913, will be replaced by a new one with 20% more capacity. The new mill, scheduled for completion by mid–1974 at a cost of $6.3 million, will be built at the Young mine site and will process ores from the Young, Coy, and Immel mines. Ore from the New Market mine was processed at the New Market mill. Zinc reserves at ASARCO's Tennessee mines have been estimated in excess of 77 million tons of ore averaging 3% to 4% zinc. Two valuable mill byproducts from the Mascot and the Young concentrators are marketed by ASARCO's American Limestone Co. Tailings are used for agricultural limestone, and the sink-float reject is sold as crushed stone.[4]

The New Jersey Zinc Co. closed the Flat Gap mine October 1, 1972. Operations at Flat Gap began in 1959, and except for 3 years, it was one of the 25 largest U.S. producers every year including 1972. The Jefferson City mine of The New Jersey Zinc Co. and the Zinc Mine Works of U.S. Steel Corp. in east Tennessee operated throughout the year. Work is underway to develop a mine and mill at Elmwood in central Tennessee.[5] Occidental Minerals Corp. (Oxymin), a subsidiary of Occidental Petroleum Corp., continued evaluation of its central Tennessee discovery and leased additional acreage in this area. Development of this property was under discussion with a major mining company.[6]

Mine production in New York, all from the Balmat-Edwards Division mines of St. Joe Minerals Corp., was 4% lower than in 1971. Output is expected to increase from 63,500 tons in 1972 to 100,000 tons in 1973.[7]

Production in New Jersey, Pennsylvania, and Virginia by The New Jersey Zinc Co. was 1,000 tons, or 1.4% below that of 1971. A mining method change instituted at the Sterling mine at Ogdensburg, N.J., increased output substantially. Operation at the Friedensville mine at Center Valley, Pa., for a long time the company's highest profit producer, were seriously affected by ground subsidence problems and flooding caused by Hurricane Agnes.[8]

In Colorado, mine output increased 4% in 1972 to almost 64,000 tons and another record. New Jersey Zinc Co.'s Eagle mine produced the largest tonnage of zinc, although somewhat less than last year. The Resurrection mine, a joint venture owned equally by Resurrection Mining Co. (a 100% owned subsidiary of Newmont Mining Corp.) and ASARCO, was next and operated continuously during 1972. Ore milled during 1972 averaged 7.6% zinc, 3.9% lead, and 2.4 ounces of silver per ton. Rated mill capacity of 700 tons of ore per day was not maintained consistently during 1972, but additional production from the recently opened No. 5 ore body should bring it up to near capacity during 1973. Ore reserves as of January 1, 1973 were estimated at 2,609,500 tons averaging 9.92% zinc, 5.16% lead, and 2.53 ounces of silver and 0.068 ounce of gold per ton.[9] Newmont Mining Corp.'s Idarado mine was Colorado's third largest producer and the Sunnyside mine of Standard Metals Corp. ranked fourth. At the Idarado mine,

[3] American Smelting & Refining Co. 1972 Annual Report. P. 9.
[4] American Smelting & Refining Co. Fourth Quarter Report. 1972, p. 2.
[5] Gulf & Western Industries, Inc. 1972 Annual Report. P. 20.
[6] Occidental Petroleum Corp. 1972 Annual Report. P. 12.
[7] St. Joe Minerals Corp. 1972 Annual Report. P. 2.
[8] Page 20 of work cited in footnote 5.
[9] Newmont Mining Corp. 1972 Annual Report. Pp. 9–10.

development during 1972 resulted in additions to ore reserves exceeding the tonnage mined and milled. Ore reserves at the end of 1972 were 2,865,000 tons averaging 4.80% zinc, 3.31% lead, 0.74% copper, and 0.03 ounce of gold and 1.75 ounces of silver per ton. Labor continues to be in short supply, but training programs during the year helped to increase the Company's mining efficiency.[10]

Mine production of zinc in Maine at 5,820 tons, was approximately the same as in 1971. Callahan Mining Corp.'s Penobscot mining and milling operations ended in July 1972 because ore reserves were exhausted. Funds set aside by the Callahan Mining Corp. were used to restore the area in a manner considered desirable by a committee of local and State representatives in cooperation with Federal agencies. In 1967, Callahan Mining Corp., The Superior Oil Co., and The New Jersey Zinc Co. joined in a program of primary exploration in Maine and adjacent areas that has proven encouraging. Two properties are scheduled for testing by drilling in 1973, and several others are in earlier stages of examination.[11] Kerramerican, Inc., a U.S. subsidiary of the Canadian company Kerr Addison Mines Ltd., has 60% interest in the Blue Hill mine at Blue Hill, Maine, after financing it to production at a cost of $6.3 million. The other 40% being retained by Black Hawk Mining Ltd., the company that did extensive development work at the mine in the 1960's. Production started October 4, 1972, and during the last quarter 53,000 tons of ore averaging 0.56% copper and 9.90% zinc were milled to 186 tons of copper and 4,500 tons of zinc in separate concentrates. All ore milled resulted from development work. The mill treated an average of 950 tons of ore per day 5 days per week because mine development was behind schedule owing to inexperienced miners and the structural complexity of the ore. Ore reserves as of December 31, 1972, including an allowance for dilution, were estimated as follows: Main Zone—zinc ore 682,000 tons (14.0% zinc and 0.4% copper), zinc-copper ore 223,000 tons (9.4% zinc and 1.4% copper), Mammoth Zone—zinc ore 147,000 tons (15.9% zinc and 1.1% copper), copper ore 366,000 tons (2.1% copper and 1.2% zinc), L.S.P. Zone—copper ore 150,000 tons (2.2% copper). Exploratory surface diamond drilling was resumed late in the year.[12]

Missouri moved up to third place among the zinc producing States with an increase in mine production of 28% for 1972. Byproduct zinc production by St. Joe Minerals Corp., Southeast Mining and Milling Division, was 5% lower than in 1971. The Buick mine-mill-smelter complex owned by American Metal Climax, Inc. (AMAX) and Homestake Mining Co. increased production as a result of mining a larger tonnage of higher grade ore. During 1972 about 1,447,000 tons of ore was mined and milled, and 189,000 tons of lead concentrate and 82,000 tons of zinc concentrate were produced. The zinc concentrate was shipped to AMAX's zinc smelter at Blackwell, Okla., for treatment.[13]

Byproduct zinc output by the Ozark Lead Co. in 1972 was slightly lower than in 1971 although production of lead in concentrate increased 25%. The Magmont mine at Bixby, Mo., operated by Cominco American Inc., a joint venture of Cominco Ltd. and Dresser Industries, Inc., produced 1,034,000 tons of ore averaging 7.9% combined lead and zinc compared with 1,040,000 tons of ore with 8.5% in 1971.[14]

Mine production of zinc in Idaho for 1972 declined 14% to 38,600 tons. The Bunker Hill mine operated by the Bunker Hill Co., a subsidiary of Gulf Resources & Chemical Corp., produced slightly more ore in 1972, but the average grade of zinc declined. Mining from the zinc ore zones in the upper levels using "blast hole stoping" began at a satisfactory rate in the latter part of the year. Greater efficiency results when this method can be used to mine large blocks of ore. Exploration and mine development work will be resumed and accelerated after improvement projects have been completed.[15] The Star-Morning mine, 70% owned by the Bunker Hill Co. and 30% by Hecla Mining Co., produced 263,595 tons of ore containing 7.36% zinc in 1972, compared with 246,053 tons with 6.72% zinc in 1971. Extensive development

[10] Pages 8–9 of work cited in footnote 9.
[11] Callahan Mining Corp. 1972 Annual Report. P. 7.
[12] Kerr Addison Mines Ltd. 1972 Annual Report. Pp. 6–7.
[13] American Metal Climax, Inc. 1972 Annual Report. P. 17.
[14] Cominco Ltd. 1972 Annual Report. P. 9.
[15] Gulf Resources & Chemical Corp. 1972 Annual Report. P. 24.

was completed in 1972 including sinking the No. 4 shaft to the 7,900-foot level, 2,000 feet of new openings on the 7,500-foot level, 2,500 feet of development of veins other than the main vein and 650 feet of cross cutting on the 1,700-foot level.[16] Independent contractors operated the Gray Rock section of the Monitor mine, owned by Day Mines Inc. They produced and milled 20,259 tons of ore averaging 8.90% zinc, 2.80% lead, and 1.15 ounces silver per ton. Ore reserves at the end of the year were adequate for 2 years of operation at the present rate of production.[17]

Utah's mine output of zinc was 15% lower in 1972 than in 1971. The Mayflower mine, leased by the Hecla Mining Co. from New Park Resources, Inc., in 1961, was closed on December 31, 1972, and the agreement was terminated. Production in 1972 totaled 114,604 tons of ore containing 0.96 ounce of gold and 5.95 ounces of silver per ton, 3.22% lead, 2.01% zinc, and 1.35% copper, compared with 124,354 tons assaying 0.51 ounce of gold and 5.12 ounces of silver, 4.01% lead, 2.44% zinc, and 1.26% copper during 1971.[18] Production at Kennecott Copper Corp.'s Tintic Division was higher in 1972 than in 1971 owing to slightly improved working conditions and a new ore zone discovered east of the main Burgin ore zone. The critical shortage of skilled miners continued throughout the year, requiring the assignments of mine development on a priority basis.[19]

Mine production of zinc in Arizona increased 30% in 1972. Cyprus Mines Corp.'s wholly owned Bruce mine near Bagdad operated at near capacity and produced 10,600 tons of zinc and 3,400 tons of copper in concentrates from 96,211 tons of ore assaying 13.7% zinc and 3.92% copper. The shaft was sunk to 2,320 feet from where an inclined tunnel was driven in mineralization 95 feet below the shaft bottom. Ore has been developed between the 2,150- and 2,300-foot levels that will extend the life of the mine at least 1 year. Known reserves are sufficient for at least 5 years at the present operating rate.[20] In 1972, mine output of zinc in New Mexico declined 9% from that in 1971. At ASARCO's Ground Hog unit in New Mexico, mining began on ore bodies leased in 1971, which are an extension of the Ground Hog deposit.[21]

In Washington, 1972 zinc mine production increased 12% to almost 6,500 tons. Pend Oreille Mines and Metals Co. mined and milled 216,000 tons of ore and produced 11,000 tons of zinc concentrate. The decline to the "Yellowhead Formation" started during the last quarter was advanced 805 feet leaving 2,365 feet to the target area. Another decline produced 11,600 tons of ore from the Lower Dolomite in August and September.[22] Callahan Mining Corp.'s property near Colville, Wash., was tested and confirmed for amenability to low-cost underground mining methods. However, the grade of the deposits was lower than hoped to justify equipping for production. A partner will be sought to share the larger expenditure required to prove additionl tonnage.[23]

Wisconsin mine production of zinc decreased 35% in 1972 because of mine closures in 1971. A 10% reduction to 11,400 tons was registered for Illinois in 1972.

SMELTER AND REFINERY PRODUCTION

U.S. slab zinc production at smelters and electrolytic plants declined 17% from last year to 706,898 short tons in 1972. The decline reflected the closure of four plants in 1971 and one in 1972, and decreased domestic mine production and imports of zinc concentrate. Monthly data published by the Zinc Institute, Inc., showed a decline in production through the year with a low in September and December. Average monthly primary smelter production was 20% less in the last 6 months compared with the first 6 months of 1972. Shipments were lower throughout the year even with the inclusion of GSA stockpile zinc and a drawdown in producers' stocks. Producers' stocks declined 37% from 50,589 tons to 31,775 tons during the year. In addition to slab zinc production, producers purchased 113,646 tons of GSA stockpile zinc during the year; they shipped 37,806 tons directly to customers and remelted 75,840 tons for upgrading.

The closure of The Anaconda Compa-

[16] Hecla Mining Co. 1972 Annual Report. P. 8.
[17] Day Mines, Inc. 1972 Annual Report. P. 3.
[18] Page 8 of work cited in footnote 16.
[19] Kennecott Copper Corp. 1972 Annual Report. P. 22.
[20] Cyprus Mines Corp. 1972 Annual Report. P. 7.
[21] Page 7 of work cited in footnote 3.
[22] Pend Oreille Mines and Metals Co. Third Quarter Report. 1972, p. 2.
[23] Page 7 of work cited in footnote 11.

ny's Great Falls, Mont., electrolytic plant on August 4, 1972, decreased the Nation's annual production capacity for zinc by 163,000 tons to 721,500. Another closure was announced for the horizontal retort smelter at Blackwell, Okla., at the end of 1973 reducing total capacity to 649,500 tons.

Refined zinc production at primary smelters and electrolytic refineries was derived from the following: Domestic ore, 57%; foreign ore, 33%; and scrap, 10%. The quantity of slab zinc produced from domestic ore in 1972 was slightly less than in 1971 but that from foreign ore and scrap decreased 36% and 9%, respectively. Primary refined zinc produced at electrolytic plants was 19% lower than in 1971 and accounted for 37% of the total slab zinc produced; smelter production (distilled) was down 16% and made up 53% of the total. Redistilled secondary slab zinc produced from scrap by primary smelters declined 8% and contributed 9% of the total; the decrease from secondary smelters was 13% for 1.5% of the total. Production of all grades of zinc declined except for an 8% increase for Brass Special. Distribution of the total by grades was as follows: Special High, 44%; High, 6%; Intermediate, 6%; Brass Special, 11%; and Prime Western, 33%.

During 1972 ASARCO at Corpus Christi, Tex., completed installation of a new Lurgi fluid-bed roaster and a $3.2 million water treatment plant that can handle both normal plant effluent and rainwater runoff. Other projects to complete the modernization program and increase plant capacity by 15% were being studied.[24] The ASARCO horizontal retort zinc smelter had operated since mid-1969 in accordance with a variance issued and renewed periodically by the Texas Air Control Board (TACB). Several studies conducted by a consulting firm and the company resulted in the same conclusion confirming the company's inability to meet the costs of the extended control facilities required to comply with TACB regulations. At one TACB hearing ASARCO urged the Board to permit the plant to be operated until mid-1975. At two subsequent hearings TACB voted to require the smelter to be in compliance with the States' air quality standards by December 31, 1973. However, at the hearing on July 26, 1973, ASARCO successfully appealed that decision and the Board voted (six to two) to allow the smelter to operate until May 31, 1975.[25]

AMAX exercised its option to purchase the American Zinc Co. electrolytic zinc plant at Sauget, Ill., in June for $3 million. AMAX will spend $19.4 million on plant improvements, process changes, and environmental protection systems.[26] The plant was scheduled to start up in the second quarter of 1973 and is expected to reach full capacity of 84,000 tons of Special High grade zinc annually by 1975. This production will be accompanied by 1.35 million pounds of byproduct cadmium and 150,000 tons of sulfuric acid.[27] AMAX announced in May the phasing out of the horizontal retort smelter at Blackwell, Okla., by the last quarter of 1973. This decision resulted from a determination that the plant could not compete profitably with the more modern electrolytic units.[28] The age of the plant and the nature of the process also render it obsolete in terms of current air quality standards.[29]

St. Joe Minerals Corp. produced 235,649 tons of zinc (zinc equivalent) in 1972 just slightly more than in 1971. Installation of a new sulfuric acid plant held back a larger output which should increase significantly in the future. A 40,000-ton expansion was scheduled for the next 3 years. Production of zinc oxide increased and shipments rose 46% due to the strong demand by the rubber and paint industries. The State of Pennsylvania requires St. Joe to recover in excess of 98% of the input of sulfur, whereas the Environmental Protection Agency (EPA) guideline was 90%. The Monaca, Pa., smelter recovery has been better than that required by EPA over the years, but the cost of meeting Pennsylvania regulations was estimated at $10 million. The ability to install the necessary process control equipment by 1977 will depend on the success of research to be conducted in 1973–74.

[24] Page 9 of work cited in footnote 3.
[25] Metals Week. Amarillo Smelter Reprieved Until 1975. V. 44, No. 31, July 30, 1973, p. 3.
[26] AMAX Lead & Zinc, Inc. Zinc Highlights. July 12, 1972, 1 p.
[27] Page 17 of work cited in footnote 13.
[28] Work cited in footnote 26.
[29] Page 17 of work cited in footnote 13.

The New Jersey Zinc Co. reported an increase of 33% in net sales in fiscal 1972 compared with fiscal year 1971. Operating income also increased 64%. Zinc metal production was down 10% from that of 1971, but pigment production was up 21%. Metal production for fiscal 1972 was 97,000 tons, and pigment production was 147,000 tons. Even though the Palmerton, Pa., smelter was operating at full capacity, the company had difficulty in meeting orders. Strong demands were also encountered for zinc oxide and zinc dust. To meet the demand, the company proposed to build a plant in Aubry, France, to manufacture a complete line of zinc oxide; the plant was scheduled to be in operation by mid-1973. In completing the phase out of the former operations at Depue, Ill., the company has leased its agriculture chemical facilities to the Mobil Oil Corp. The New Jersey Zinc Co. continued its use of a portion of the Depue zinc refinery to produce zinc dust pigment from zinc scrap.[30] The company has also announced that it was planning to expand its facilities at Palmerton.

The Bunker Hill Co. in Idaho produced 101,700 tons of zinc in 1972, 8.2% more than in 1971. Engineering commenced on a leach-electrowinning facility for the recovery of copper from matte, spiess, and residues from the lead and zinc plants. The new plant may come onstream in 1974. The material that will be processed at this plant was sold to other producers in the past. The operation of Bunker Hill was much improved in 1972 over that of 1971. During discussions between the company, the State of Idaho, and EPA regarding sulfur dioxide emissions and effluent treatment to the south fork of the Coeur d'Alene River, it was decided that Bunker Hill will be able to meet the State plan, but EPA has not promulgated final regulations for Northern Idaho and Eastern Washington area.[31] Company officials have also considered adding to its zinc-producing capacity.

National Zinc Co. was sold to investors from Bartlesville, Okla.; however, National Zinc continued to manage the inspection for the new owners. The company operated the Bartlesville plant since its inception in 1907. The plant has a horizontal retort smelter that produces over 50,000 tons of slab zinc per year. Plans were to convert the operation to an electrolytic plant during the next 2 years with the same capacity.

Secondary Zinc Smelters.—Zinc recovered from zinc-bearing scrap was 387,761 tons in 1972, an 8% increase over that of 1971. New scrap consisting of semimanufactured forms, primarily zinc- and copper-base alloys, accounted for 79% of the new and old scrap processed. When compared with 1971, increases in zinc recovery were realized for all categories of new scrap, and copper- and aluminum-base alloys in old scrap; but decreases were noted for zinc- and magnesium-base alloys. Most of the zinc recovered, 46%, was from brass and bronze followed by slab zinc, 23%; chemical products, 13%; and zinc dust, 10%.

Slag-Fuming Plants.—Slag fuming plants process hot and cold lead blast-furnace slags, which contain 7% to 15% zinc, to produce zinc oxide fume. The oxide is sent either to zinc smelters or electrolytic refineries for recovery of zinc, or it is sent to the consumers as zinc oxide. During the year three plants were operating:

ASARCO	El Paso, Tex.
ASARCO	East Helena, Mont.
The Bunker Hill Co	Kellogg, Idaho

The East Helena plant was purchased by ASARCO from The Anaconda Company during the year. The transfer took place on July 3, 1972.

Byproduct Sulfuric Acid.—In 1972, there were nine plants with facilities for roasting zinc sulfide concentrates. Seven plants were equipped with sulfuric acid producing units, one of which was solely a roasting operation producing calcine for processing to zinc oxide or zinc metal. Two horizontal retort smelters did not have sulfuric acid producing facilities. In 1972, production of byproduct sulfuric acid from the zinc plants and two lead smelters was 859,103 tons, compared with 971,946 tons in 1971.

Zinc Dust.—Production of zinc dust was 59,358 short tons in 1972, an increase of 18% over that of 1971. Zinc dust produced from distilled scrap metal accounted for 40,123 tons, 41% more than in 1971.

[30] Page 20 of work cited in footnote 5.
[31] Pages 24–25 of work cited in footnote 15.

CONSUMPTION AND USES

Consumption of slab zinc in the United States during 1972 was 1,418,349 tons, an increase of 13% over that of 1971. The zinc content of ore and concentrate used directly to make pigments and salts and in galvanizing was 118,305 tons (119,254 in 1971); and the zinc content of scrap processed to make alloys, zinc dust and salts totaled 292,099 tons, up 5% from 1971. The overall total was 1,828,753 tons, an increase of 11% over that of 1971.

Slab zinc consumption was reported by nearly 600 users in 1972. Galvanizing accounted for 36% of the total slab zinc consumed; brass products, 14%; diecasting alloys, 40%; other zinc-base alloys, 1%; rolled zinc, 3%; zinc oxide, 4%; and other uses, 2%. Nearly all the use categories showed gains over last year. Of the 164,290 tons net gain, 43,452 tons of the increase was used in galvanizing, 41,661 tons for brass products, 62,109 tons for diecasting alloys, 6,364 tons for rolled zinc, and 11,949 tons for zinc oxide. Losses were noted in other uses.

Distribution of slab zinc consumed in 1972, by grade, is as follows: Special High grade, 49% High grade, 10%; Intermediate, 2%; Brass Special, 9%; Prime Western, 30%; and Remelt less than 0.1%. Compared with 1971, consumption of all grades increased—Special High grade, 12%; High grade, 25%; Intermediate, 14%; Brass Special, 17%; Prime Western, 9%; and Remelt, 40%.

Slab zinc consumed by rolling mills in 1972 was 45,216 tons, a 16% increase over that of 1971. Production of rolled zinc products increased 18%, to 45,216 tons. Sheet and strip consumed 62%, and 30% was used for photoengraving plate. Imports doubled over last year to 485 tons, and exports increased 43%, to 2,419 tons. More than 40,000 tons of zinc was rerolled from scrap in 1972, and the total rolled was 86,980 tons, compared with 58,539 tons in 1971.

The leading consumers of slab zinc in 1972 by State were Ohio with 14% of the total, followed in order by Illinois with 13%, Pennsylvania 12%, Michigan 11%, Indiana 10%, and New York 8%. The industries using zinc in these six States accounted for 68% of the slab zinc consumed, which was the same percentage as the last 2 years. Michigan was first in the use of zinc for diecastings, Ohio was for galvanizing, and Connecticut for brass mill products.

ZINC PIGMENTS AND SALTS

Production.—Published data for zinc pigments and compounds include two major items, zinc oxide and zinc sulfate. Information for leaded zinc oxide and zinc chloride was withheld in 1971 and 1972 to keep individual company data confidential. Figure 2 shows the trends in leaded zinc oxide and zinc chloride shipments prior to 1971.

Production of zinc oxide in 1972 was 237,015 tons, a 10% gain over 1971 production. Shipments increased by a greater percentage, reducing stocks to a low level. Zinc sulfate production declined from 45,929 tons to 38,897 tons, and shipments declined by a still larger tonnage to 39,595 tons.

Zinc pigments and compounds were made from a variety of semiprocessed materials including zinc ore and concentrate, slab zinc, and scrap. Lead-free zinc oxide, the major product in the zinc pigments group, was obtained from three sources: 57% from ores or concentrates (American process), 27% from metal (French process), and 16% from secondary materials. The ores used to produce American-process zinc oxide were 82% domestic and 18% imported. The major part of zinc sulfate production, 62%, came from secondary materials. For both oxide and sulfate, the tonnage and percentage of imported concentrates used in 1972 decreased from those of 1971.

A major change in zinc oxide producers took place in 1972 as ASARCO purchased zinc oxide plants at Columbus, Ohio, and Hillsboro, Ill., formerly operated by the American Zinc Co.

Consumption and Uses.—Shipments of zinc oxide by industry usage indicated an increase of 8% for total shipments in 1972. Rubber continued to be the major consuming industry, taking 53% of the total of lead-free zinc oxide. Photocopying continued a growth trend and became the second largest use, having more than doubled in volume in the last 5 years. Zinc sulfate shipments declined partly as a result of a 35% reduction in agricultural use. Consumption of leaded zinc oxide was only a small part of total zinc compound use. Zinc chloride registered a modest increase in consumption in recent years.

Prices.—At the beginning of 1972, prices in effect since July 1, 1971 were as follows: American-process pigment-grade lead-free zinc oxide, 17.50 cents; French-process lead-free oxide, 18 cents; and electrophotographic, 20.25 cents. Increases on May 1, 1972, October 27, 1972, and December 25, 1972, raised these by yearend to the following: American-process, pigment-grade, lead-free oxide, 18.25 to 19 cents; French-process, 18.75 to 20.50 cents; electrophotographic, 21 cents. Prices at the end of the year varied in relation to quality, quantity, and locality where available. As of December 25, 1972, U.S.P.-grade was 1 cent higher than electrophotographic, at 22 cents, and activation grade, the lowest quality quoted, ranged from 15.75 cents to 17.50 cents. The price for leaded zinc oxide, 12%, ranged from 14.50 cents per pound in January to 15.75 cents in December 1972.

Foreign Trade.—Exports of zinc oxide decreased 8% from the record amount of 1971 to 6,172 tons in 1972, and exports of lithopone rebounded from the low point in 1971 to a normal level of over 1,300 tons in 1972. Destinations were widespread throughout the world. Imports of zinc pigments and compounds increased by 24% to a record 25,934 tons; zinc oxide was the major component and the major cause of the increase. Canada and Mexico were the

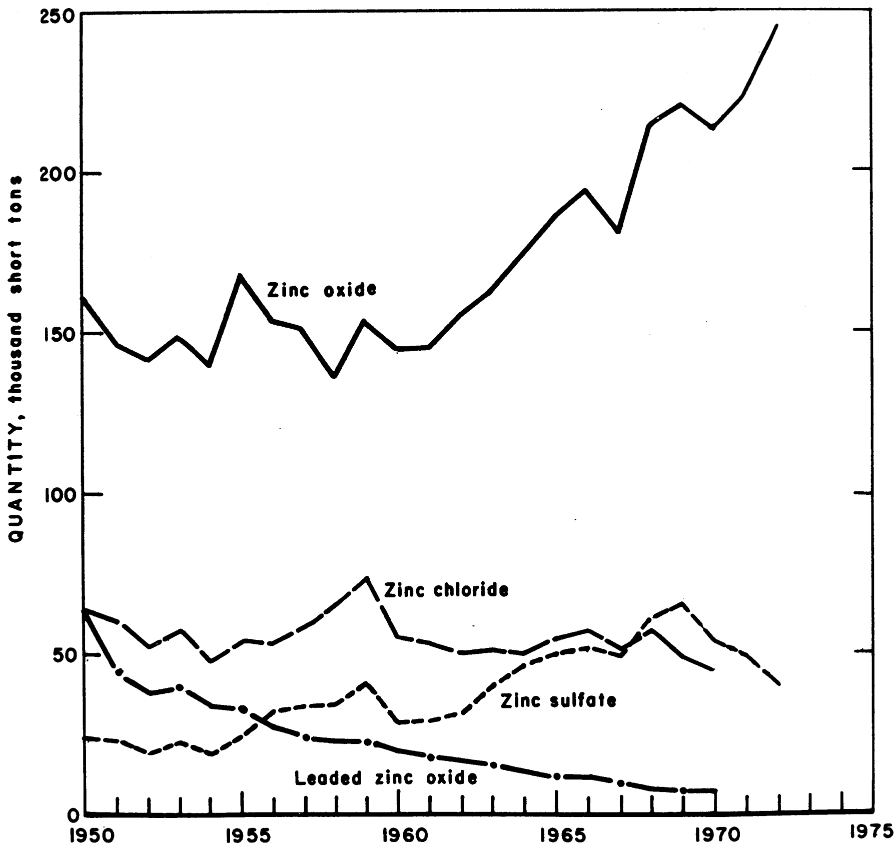

Figure 2.—Trends in shipments of zinc pigments.

principal sources, with minor contributions from the European Economic Community (EEC) countries. About one-fourth of the increase in demand for zinc oxide that developed during 1972 was satisfied by the increase in imported oxide.

STOCKS

Producer Stocks.—According to American Zinc Institute, Inc. data, stocks decreased until midyear to 21,221 tons at which time GSA stockpile zinc began to give some relief and producers stocks showed some gains, a trend that extended to the end of the year. The total decline in producer stocks for 1972 was 49%, the lowest yearend inventory since 1950. Stocks at secondary smelters gained continuously, with small fluctuations, ending 1972 with 1,225 tons, a threefold increase from yearend 1971.

Consumer Stocks.—Slab zinc inventories at consumer plants at the end of 1972 were 126,141 short tons, an increase of 38% over the ending stock for 1971. Prime Western grade accounted for the largest increase followed by Special High grade, Brass Special, and High grade.

Government Stockpile.—During 1972, the GSA stockpile inventory was reduced from 1,137,937 tons to 949,583 tons indicating that 188,354 tons of slab zinc went into domestic supply from the Government stockpile.

PRICES

The price of Prime Western zinc at the beginning of 1972 was 17 cents per pound; High grade and Special High grade prices were at 17.85 and 18 cents per pound, respectively. These prices remained unchanged since they were established July 26, 1971. A ceiling price of 17 cents per pound for Prime Western zinc was established August 16, 1971, by the President's Economic Policy during which time the Price Commission was established. In January 1972, St. Joe Minerals Corp. applied to the Price Commission for a 5.6% price increase in zinc; The New Jersey Zinc Co. applied in March. An increase was approved for St. Joe Minerals Corp. on March 16, 1972, at which time Prime Western zinc was sold at 18 cents per pound; High grade and Special High grade went to 18.85 and 19 cents per pound, respectively. At the same time ASARCO, The Bunker Hill Co., and AMAX withdrew from the zinc market. One by one the producers applied for price increases, which were granted one by one, and by May 12 all U.S. producers were in line with one domestic zinc price. Another round of price increases came in December with The New Jersey Zinc Co. being the first to receive approval from the Price Commission on December 20 to raise its price an average of 2.75% for all zinc products, bringing Prime Western to 18.5 cents, High grade to 19.35 cents, and Special High grade to 19.5 cents per pound. On December 21, St. Joe Minerals Corp. received permission for a price increase of 2.91%, which resulted in having this company's products bringing 18.52 cents per pound for Prime Western zinc, 18.78 for Continuous Galvanizing grade, 19.4 for High grade and 19.55 cents per pound for Special High grade. The above sequence of events led to a three-tier domestic market for zinc continuing to yearend. A number of requests that were made during the year to the Cost of Living Council to declare zinc an international commodity and free it from price control were rejected. On January 11, 1973, Phase 3 of the President's Economic Stabilization program took effect, at which time the Price Commission was phased out. Zinc prices began to increase with ASARCO taking the lead on January 18, 1973.

On March 6, 1972, Canadian producers boosted their price of zinc to 18 cents per pound (Prime Western equivalent). Within 1 week this move was followed by Australia and Peru. On April 27, and before the domestic zinc price was established at 18 cents per pound for Prime Western zinc, the foreign price was boosted to 19 cents per pound (Prime Western equivalent). This price remained until December 1 when an increase to 19.5 and 20 cents per pound came into effect for imported (Prime Western equivalent) zinc. A new grade of foreign zinc was introduced at the same time called Continuous Galvanizing grade (CGG) zinc at a price of 20.25 cents per pound. From December 1 to yearend there was a 2-cent spread between the ceiling price of domestically produced zinc and imported metal selling in the United States.

The average monthly London Metal Exchange price increased from the beginning of the year price of 17.21 cents to 17.99 cents per pound (U.S. equivalent) in March, after which it declined to 16.48 cents per pound in August. In November the average price advanced to 17.16 cents per pound, followed by a decline to 17.0 cents per pound in December. The general decline in price was a result of the decline in the sterling exchange rate. The European producer price quoted at £150 per metric ton (16.46 cents per pound U.S. equivalent in June 1971 and 17.78 cents per pound in May 1972) effective since June 17, 1971, remained until July 5, 1972, when the price was increased to £160 per metric ton (17.77 cents per pound U.S. equivalent). Although there was an increase in the European producer price, there was actually no increase in the equivalent cents per pound price because of the lowering average dollar value of the pound sterling. Another increase took place on November 27, at which time the price became £173 per metric ton (18.46 cents per pound U.S. equivalent).

FOREIGN TRADE

Exports of slab zinc dropped drastically from 13,346 tons to 4,324 tons in 1972, of which 88% was shipped to the United Kingdom. Exports of rolled zinc products, sheet, plate, strip, etc., increased 43% to 2,419 tons of which Canada received more than half, 1,329 tons.

General imports of zinc in ore declined 26% to 254,868 tons in 1972, reflecting smelter closures in 1971 and 1972 and decreasing availability of foreign concentrates. Canadian supplies of ore declined from 209,084 to 135,534 tons. Receipts from Mexico dropped from 89,845 to 57,315 tons, and receipts from Honduras dropped from 21,512 to 17,370 tons. Nicaragua supplied ores for the first time in 3 years in the amount of 10,960 tons of contained zinc. General imports of metal increased 64% to 522,612 tons in 1972. Canada was the largest supplier with 271,130 tons, an 80% increase over 1971. Other large suppliers of metal each ranging between 30,000 and 40,000 tons were Australia, Belgium-Luxembourg, West Germany, Japan, and Peru.

Imports of ore for consumption declined 63% from 467,368 tons in 1971 to 174,063 tons in 1972. The latter figure is significantly less than general imports which suggests a buildup of ores in the bonded warehouses. Metal imports for consumption increased 59% over 1971 to 516,643 tons in 1972, slightly less than the general imports of metal for the year. In addition, for the first time in the history of zinc, imports of metal were greater than the zinc metal produced from domestic ores, and the first time since 1937 imports of metal exceeded the quantity of zinc in imported ores and concentrates.

There were no changes in the tariff rates in 1972. The duties on unmanufactured zinc and zinc-containing materials were as follows: Slab zinc, 0.7 cent per pound; zinc ores, concentrates, and fume, 0.67 cent per pound (on zinc content less specified allowable deductions for processing losses); zinc scrap, 0.75 cent per pound; and zinc dust, 0.7 cent per pound. The duty rate for unwrought alloys of zinc, which includes diecasting alloys, was 19% ad valorem.

WORLD REVIEW

World mine production of zinc recovered from the temporary setback of 1971 to a rate more in keeping with the long-range forecast of demand proportional to world population growth. Zinc metal production also increased, setting a new record. World consumption resumed its upward climb with a 9% increase over the usage in 1971.

The world pattern was in sharp contrast to the situation in the United States where mine and smelter production decreased as consumption continued to grow, making the United States increasingly dependent on imported concentrates and metal. The possible source countries having an excess of at least 100,000 tons of mine production of zinc over internal consumption in 1972 were, in decreasing order of excess, Canada, Australia, Peru, Mexico, Poland, North Korea, Zaire, and Ireland. The first five of these were planning new smelter facilities or expansion of existing units in order to increase the proportion of metal refined in the source country. This worldwide trend will make concentrates less readily available to U.S. smelters and will increase U.S. dependency on metal imports.

New plants were planned or were under construction in Belgium, West Germany, the Netherlands, and Italy. New production will be partly offset by closures of old plants and so was expected to keep pace only with consumption growth within the EEC.

Algeria.—Société Nationale de Recherche et d'Exploitation Minière (Sonarem), the Algerian state mining agency, signed a contract with Dravo Corp. for the expansion and reconstruction of the El Abed lead-zinc mine to increase production from 800 to 3,300 tons per day.[32] Production of zinc (metal content) in 1972 was estimated to be about 18,300 tons.

The El Abed ores are part of the Bou-Beker deposits, which have been mined principally in Morocco but have been extended across the border into Algeria. The Touissit mine on the west end in Morocco was still operating, the Zellidja mine in the center and its small smelter in Morocco have been closed, and apparently the bulk of the ore reserves will now be at El Abed in Algeria. These reserves were estimated to contain 391,000 tons of zinc and 68,000 tons of lead, metal content.

Argentina.—The two zinc plants in Argentina achieved a new record output of about 45,000 tons of zinc metal. Mine production continued at a high level at Aguilar producing 50,204 tons of lead concentrate and 96,208 tons of zinc concentrate.[33] Mine production (metal content) was estimated at 40,000 tons. Consumption of zinc in Argentina remained about the same as in 1971 at 37,500 tons of metal.[34]

Australia.—Mine production of zinc in Australia rose 12% in 1972 to 554,000 tons, and refined zinc production rose 15% to 327,000 tons. Of this, 117,000 tons of slab zinc was consumed in Australia, two-thirds for galvanized products.[35] Only about 6,000 tons of zinc in Australian concentrate was exported to the United States, but 40,000 tons was exported to the U.S. as slab zinc; 133,000 tons of zinc in concentrate was exported to Japan.

The South Mine at Broken Hill (Broken Hill South Ltd.) was closed July 7, 1972. Operations at this mine began in 1885 and through acquisitions and leases had grown to include the whole central region of the Broken Hill lode, one of the great zinc mines of the world. The directors cited declining tonnage and grade of ore, adverse metal prices, and increased working costs as the reason for the closure.[36] Other parts of the Broken Hill lode were still being mined by the Zinc Corp. and New Broken Hill Consolidated, Ltd.

Production at some of the largest Australian zinc mines in 1972 was estimated as follows:

	Tons
Broken Hill South mine [1]	15,000
Zinc Corporation Ltd. mine, Broken Hill	87,000
New Broken Hill Consolidated mine	156,500
North Broken Hill [1]	48,000
Mount Isa Mines Ltd.	103,600
West Coast mines, Tasmania [1]	70,700

[1] Based on reports for fiscal year ending June 30, 1972.

Beneficiation tests have been completed by E.Z. Industries Ltd. for the willemite deposits at Beltana, South Australia, and treatment by fuming processes was investigated.

Several companies were exploring in the Captain's Flat area in New South Wales after Jododex Australia Proprietary Ltd. made a discovery reported to contain 7,000,000 tons of ore assaying 9.4% zinc, 2.0% copper, and 3.3% lead.[37]

The Australian Mining and Smelting Co. Ltd. (AM&S) through its subsidiary, Commonwealth Smelting Ltd., acquired the Im-

[32] World Mining. Africa. V. 8, No. 11, October 1972, pp. 73–74.
[33] Page 11 of work cited in footnote 7.
[34] Monthly Bulletin of the International Lead and Zinc Study Group. Lead and Zinc Statistics. V. 13, No. 5, May 1973, p. 18.
[35] Zinc Institute, Inc. A Review of Zinc in the United States in 1972. P. 14.
[36] Broken Hill South Ltd. 1972 Annual Report and Notice of Meeting. P. 5.
[37] World Mining. Base Metal Prospecting Excitement on Two Areas of New South Wales. V. 8, No. 12, November 1972, p. 52.

perial smelter at Avonmouth, in the United Kingdom on November 27, 1972. Another subsidiary of AM&S, Australian Overseas Smelting Pty. Ltd., engaged in a 50–50 joint venture to construct a new electrolytic zinc plant at Budel in the Netherlands. These ventures were intended to provide a secure outlet in the EEC for concentrates from New Broken Hill Consolidated Ltd. and Zinc Corp. mines, owned by AM&S.[38]

The electrolytic zinc refinery of E.Z. Industries Ltd. at Risdon, Tasmania, accounted for 62% of Australian zinc metal production, the smelter of Sulphide Corp. Pty. Ltd. at Cockle Creek, New South Wales, a subsidiary of AM&S, produced about 23%, and the zinc plant at the Port Pirie lead smelter of Broken Hill Associated Smelters Pty. Ltd., accounted for about 15%.

Belgium.—La Société des Mines et Fonderies de Zinc de la Vieille-Montagne, S.A. had four plants in Belgium and four in France concerned with zinc metal and zinc oxide production. In 1972 Vieille-Montagne produced a record 268,000 tons; capacity was expanded at the Balen, Belgium, electrolytic zinc plant and at the zinc oxide-zinc dust plant at Creil, France. The zinc-producing capacity of Vieille-Montagne in 1972 was 286,000 tons of electrolytic zinc and 55,000 tons of thermic zinc.[39] Other Belgian producers were Hoboken-Overpelt (121,000 tons capacity) and Société de Prayon, S.A. (68,000-ton capacity); Overpelt planned new construction to increase capacity by 1974, and Prayon completed a new electrolytic plant at Ehein, after closing its older retort plant.

Bolivia.—Although tin was the major metal produced and exported from Bolivia, zinc was second in value and first in tonnage in 1972. Zinc exports, mostly in concentrates, were 43,700 tons, metal content, with 30,100 tons coming from the Mina Matilde.

In December 1972, the Bolivian Government paid $13.4 million to Matilde Mine Corp. (United States Steel and Philipp Brothers., a division of Engelhard Industries Inc.) as indemnification for the nationalization of the Matilde plant in 1971. Production in 1972 was under Bolivian state mining corporation management Corporación Minera de Bolivia (COMIBOL). Ore was reported to run about 14% zinc and 1.1% lead. Concentrates were shipped across Lake Titicaca and to Japan through the Peruvian port of Matarani. COMIBOL also operated a few small zinc mines that sold concentrates for smelting in Peru. The "Medium Miners", made up of private companies smaller than COMIBOL, produced about 3,900 tons of zinc in concentrates.

Soviet and Polish interests conducted feasibility studies for the construction of zinc smelters to produce up to 50,000 tons of zinc annually at proposed sites near Corocoro and Potosí.

Brazil.—Zinc was produced at two plants, one operated by Companhia Mercantile Industrial Inga and the other by Companhia Mineira de Metais. Both produced electrolytic zinc from the silicate and oxide ores of Vazante, Minas Gerais. The Inga operation also produced small amounts of zinc oxide and zinc powder. The combined metal production of these two plants was 17,811 tons in 1972. Brazil depends on additional zinc imports to meet its requirements; its estimated consumption was 51,800 tons.

The two major zinc districts were at Vazante and Januaria in Minas Gerais. Januaria had no production in 1972. Both deposits produced calamine and willemite ores with residual amounts of sulfides. Reserves at Vazante were estimated at 2.5 million tons of contained zinc.[40]

Canada.—Mine production of zinc increased slightly in 1972 to 1.41 million short tons of zinc content in concentrates compared with 1.40 million tons in 1971. Zinc smelter production increased from 410,000 tons in 1971 to an estimated 525,400 tons in 1972. Hence, Canada retained its enormous lead as first in world zinc mine production and retained fourth rank in world zinc metal production. Several smelter expansions were planned to increase Canada's share of metal production in the future. Consumption of zinc in Canada in 1972 was estimated at 128,000 tons, an increase from the 1971 consumption of 111,000 tons. Obviously, Canada has the major part of its metal production available for export in addition to the

[38] New Broken Hill Consolidated Ltd. Holdings Ltd. 1972 Annual Report. P. 5.

[39] La Vieille-Montagne (Brussels, Belgium). Promotional Publications for Industry. September 1972, p. 31.

[40] Intermet Bulletin. V. 2, No. 2, October 1972, p. 15.

large volume of zinc concentrates not converted to metal. Shipments of refined primary metal to the United States in 1972 were 276,200 tons and to other countries, 116,500 tons. Exports of concentrates from Canada decreased in 1972 to 752,000 tons (zinc content) from 866,200 tons in 1971, because more concentrates were converted to metal.

In the Northwest Territories, Cominco Ltd. continued to operate the Pine Point mines (69% Cominco owned) and mined 3.8 million tons of ore with an average grade of 2.7% lead and 6.2% zinc and probably recovered about 220,000 tons of zinc. Ore reserves reported at the end of the year were 40.9 million tons with average grade of 2.4% lead and 6.0% zinc.[41] Cominco started to develop a mine on Little Cornwallis Island in the Arctic Islands, 600 miles north of the Arctic circle, on the Polaris mine property of Arvik Mines Corp. Ltd. (75% Cominco, 25% Bankeno Mines Ltd.). A winter underground development program confirmed the existence of a deposit of 20 million tons of minable ore with a metal content of 20% combined zinc and lead.[42]

The Anvil Mining Corp. Ltd. completed the third year of operation at its open pit mine and concentrator near Faro, Yukon Territory. The mill treated nearly 8,000 tons of ore per day, the average grade was 10.8% combined lead and zinc. Concentrates sold contained 103,567 tons of lead and 114,682 tons of zinc. Anvil was owned 60% by Cyprus Mines Corp. and 40% by Dynasty Exploration, Ltd.[43] United Keno Hill Mines Ltd., at Elsa, Yukon Territory (48.4% Falconbridge) milled 81,000 tons of ore to produce 2,504,000 ounces of silver, 3,054 tons of lead, 1,653 tons of zinc, and 47,000 pounds of cadmium during 1972. Zinc production declined because of a decrease in ore grade. Two of the mines in the group were closed in the fourth quarter; exploration continued on other properties at Keno and near Whitehorse.[44]

British Columbia zinc production decreased about 12% in 1972, but zinc continued to be second only to copper in value of metals produced in the province. The estimated value of zinc production was about $47 million. Exploration activity decreased in 1971 and 1972 from the high rate of 1970; no major mineral properties were in the development stage in 1972. Five mines producing zinc-lead-silver ores operated with mill capacity as shown: Sullivan, 11,000 tons per day; Reeves MacDonald Annex, 1,000 tons per day; Nadina, 500 tons per day; Silmonac, 150 tons per day; and Highland Bell, 110 tons per day.[45] One copper-lead-zinc-silver mine, the Lynx, was operated at Buttle Lake at a rate of 750 tons per day. Cominco was the major producer at its Sullivan mine, mining 1,925,000 tons with a combined zinc-lead grade of 10.8%. Traditionally this mine has produced about 100,000 tons of zinc per year. Bralorne Resources was managing a joint venture, "Bradina", with Pacific Petroleum Ltd. to bring into production the Nadina mine at Owen Lake south of Houston. The mill began production in May 1972. Ore reserves were estimated to be 551,650 tons with average grade of 0.1 ounce of gold and 10 ounces of silver per ton, 0.76% copper, 2.1% lead, and 6.96% zinc. The bulk lead-zinc concentrate is contracted to Japanese companies.[46] The Reeves MacDonald Mines Ltd. continued to produce concentrates destined for the Bunker Hill smelter from the Annex mine at the rate of about 10,000 tons of zinc per year.[47] Kam-Kotia and Burkam Mines Ltd. continued a joint venture operating the Silmonac property in the Slocan district and shipping ore to the nearby Carnegie mill. In 1971, ore had an average grade of 6.39% lead, 6.6% zinc, and 17.99 ounces of silver per ton and produced 2,400 tons of contained zinc shipped to the Bunker Hill smelter. The Highland Bell or Beaverdell property with values chiefly in silver was operated by Teck Corp. Ltd. with zinc concentrates going to Cominco at Trail at the rate of about 300 tons of zinc metal per year.[48] Western Mines Ltd. operated the Lynx mine and developed the nearby Myra group at Buttle Lake on Vancouver Island. Ownership

---

[41] Pine Point Mines Ltd. 1972 Annual Report. P. 5.

[42] Page 8 of work cited in footnote 14.

[43] Cyprus Mines Corp. 1972 Annual Report. P. 8.

[44] Falconbridge Nickel Mines, Ltd. 1972 Annual Report. P. 35.

[45] Western Miner. V. 46, No. 4, April 1973, p. 101.

[46] Canadian Mines Handbook—1972–73. Northern Miner Press, Toronto, July 1972, p. 233.

[47] Pend Oreille Mines and Metals Co. Nine Months Report. Sept. 30, 1972, p. 2.

[48] G. S. Barry. Zinc. Can. Min. J., v. 94, No. 2, February 1973, p. 89.

by W. R. Grace & Co. was increased to 25% during 1972.[49] The Lynx mine produced 22,900 tons of zinc in 1971.

Cominco announced plans late in 1972 to reopen the H. B. zinc-lead mine near Salmo, British Columbia, replacing the production that formerly came from the Bluebell mine, which closed late in 1971. Production was planned to be 1,000 tons per day early in 1973.

The Hudson Bay Mining & Smelting Co. Ltd. brought into production two new mines in Manitoba in 1972, the White Lake mine with a daily production of 450 tons and the Ghost Lake mine with a daily output of 250 tons. The Flexar mine in Saskatchewan, with a rate of 340 tons per day, was closed in November 1972. The company now operates nine base metal mines in the Flin Flon region. Reserves given for White Lake are 330,000 tons, 5.4% zinc, 2.6% copper; reserves for Ghost Lake are 290,000 tons, 14.5% zinc, 1.58% copper. Taking the nine or more mines as a whole, Hudson Bay reports ore reserves of 17,288,600 tons, 2.9% copper, 3.3% zinc, 0.04 ounce gold, and 0.6 ounce silver. The zinc refinery treated 87,832 tons of 48.0% zinc concentrate from Hudson Bay mines, 42,901 tons of purchased 52.5% zinc concentrate and 41,651 tons of 60.4% zinc oxide fume to produce 77,023 tons of zinc.[50]

Sherritt Gordon Mines, Ltd., was a substantial zinc producer in Manitoba with a copper-zinc operation at the Fox mine and a copper-zinc project under development at the Ruttan mine. The Fox mine produced 4,493 tons of zinc in 1972. Construction work at the Ruttan pit progressed through 1972, and production was expected to start in 1973. Ore reserves at the Fox mine were 13,300,000 tons, 2.01% copper, 2.23% zinc and at the Ruttan mine were 51,000,000 tons, 1.47% copper and 1.61% zinc. (Lynn Lake reserves were in nickel and copper values and were not published in 1972.)[51]

The Kidd Creek mine of Texasgulf, Inc., near Timmins, Ontario, continued to be Canada's largest zinc producer. The open pit mine is the present source of most of the copper, lead, zinc, silver, and cadmium production, but the underground mine (a downward extension of the ore in the pit) was being developed so that it can supply 2,000 tons per day by the end of 1973 and will eventually supply the entire 10,000 tons daily required for concentrator feed after the next several years. Zinc production in 1972 was 616,700 tons of 52% concentrate for about 320,000 tons of zinc. Part of this concentrator production was used to produce 60,100 tons of zinc metal in the new zinc plant. The zinc plant conversion from batch leaching to a continuous operation was started in 1972 and should be completed by 1974; this change will increase annual zinc metal capacity from 120,000 to 150,000 tons.[52]

Mattabi Mines, Ltd., owned 60% by Mattagami Lake Mines Ltd., and 40% by Abitibi Paper Co. Ltd., began production in July 1972 at a new open pit operation near Ignace, Ontario. The design rate of 3,000 tons per day was almost realized during the 5 months of full operation. Ore treated averaged 11.97% zinc, 1.27% copper, 1.27% lead, and 4.99 ounces of silver per ton. Ore reserves reported July 1972 were 12,866,000 tons, 7.60% zinc, 0.91% copper, 0.84% lead, and 3.13 ounces of silver per ton. Zinc concentrates produced were shipped to Canadian Electrolytic Zinc Ltd. at Valleyfield, Quebec, to Quebec City for export and to the United States; the zinc portion of mill production was 80,378 tons of concentrates grading 55.14%.[53]

The Geco mine, operated by Noranda Mines Ltd. in the Manitouwadge area, Ontario, mined 1,815,000 tons of ore that averaged 2.12% copper, 4.30% zinc, and 1.93 ounces of silver per ton; concentrates contained 61,300 tons of zinc. Ore reserves at yearend were 29,400,000 tons with average grade 1.94% copper, 4.22% zinc, and 1.75 ounces of silver per ton.[54]

Jameland Mines Ltd., owned 30.3% by Kam-Kotia Mines Ltd., sent ore to the Kam-Kotia mill in 1972, but closed its copper-zinc mine December 30, 1972.[55] Concentrates produced in 1971 contained 1,661 tons of zinc destined for U.S. smelters.

Willroy Mines Ltd. continued to operate the Willroy mill at the rate of 1,600 tons

[49] W. R. Grace & Co. 1972 Annual Report. P. 19.
[50] Hudson Bay Mining and Smelting Co., Ltd. 1972 Annual Report. P. 19.
[51] Sherritt Gordon Mines Ltd. 1972 Annual Report. Pp. 8–20.
[52] Texasgulf, Inc. 1972 Annual Report. P. 4.
[53] Mattagami Lake Mines Ltd. 1972 Annual Report. P. 6.
[54] Noranda Mines Ltd. 1972 Annual Report. P. 10.
[55] Page 85 of work cited in footnote 48.

per day on ores from the Willroy and Willecho properties in the Manitouwadge area. Ore processed was 431,067 tons averaging 1.10% copper, 3.27% zinc, and 1.41 ounces of silver per ton (estimated 11,500 tons zinc). Ore reserves at the end of the year were 936,000 tons, 0.78% copper, 3.95% zinc, and 1.71 ounces of silver per ton.[56]

Selco Mining Corp. Ltd. operated the South Bay mine in the Uchi Lake area to feed its 500-ton-per-day mill, which produces zinc concentrates for export to France and copper-silver concentrates for Noranda. For the year ending March 31, 1972, the mill treated 175,100 tons of ore grading 2.29% copper, 13.11% zinc, and 3 ounces of silver per ton (to produce an estimated 18,000 tons of zinc). Ore reserves were 580,000 tons, 2.27% copper, 14.24% zinc, and 3.69 ounces of silver per ton after allowance for recovery and dilution.[57]

The largest zinc mine production in the province of Quebec came from the Mattagami mine of Mattagami Lake Mines, Ltd. Ore milled in 1972 totaled 1,370,167 tons, 7.4% zinc, 0.56% copper, 0.017 ounce of gold per ton, and 0.88 ounce of silver per ton. Zinc concentrates produced contained 89,850 tons of zinc. Ore reserves without allowance for dilution, were 14,661,927 tons, 8.9% zinc, 0.67% copper, 0.012 ounce of gold and 1.08 ounces of silver per ton. Mattagami Lake Mines owns 51.7% of the Canadian Electrolytic Zinc plant at Valleyfield and Noranda owns 31.4% of Mattagami Lake. Exploration conducted by Mattagami Lake has developed about 2,000,000 tons of ore reserves in the Sturgeon Lake area of Ontario, grading 6% to 8% zinc with copper, lead, gold, silver values; more drilling remains to be done in this area.[58]

Orchan Mines Ltd., owned 47.1% by Noranda Mines Ltd., is another major zinc producer in Quebec. The Orchan mill treated 376,800 tons of ore, 10.6% zinc and 1% copper including 2,700 tons from the new Garon Lake development at the end of the year. Reserves in the Orchan mines were 1,897,000 tons, 9% zinc and 1.2% copper. Additional reserves were being developed on the Garon Lake and Norita properties, both within truck-hauling distance of the Orchan mill.[59] Based on 1971 mill performance, Orchan probably produced 36,000 tons of zinc in 1972.

Kerr Addison Mines, Ltd., 43.6% owned by Noranda, operated the Normetal mine in northwestern Quebec. The concentrator milled 326,500 tons of ore assaying 1.73% copper, 5.29% zinc, 0.026 ounce of gold per ton, and 1.43 ounces of silver per ton. Zinc concentrates contained 14,666 tons of zinc. Ore reserves on December 31, 1972, were 271,000 tons, 1.6% zinc; production is expected to cease during the third quarter of 1973.[60] Kerr Addison also controlled Joutel Copper Mines, Ltd., which during 1972 converted the Joutel mill to treat zinc rather than copper ores. The zinc-bearing part of 1972 production was 70,200 tons averaging 12.16% zinc, producing 6,334 tons of zinc in concentrates. Reserves at yearend were 72,600 tons averaging 2.02% copper and 144,600 tons averaging 11.18% zinc, all of which was scheduled for mining in 1973.

Falconbridge Copper Ltd. operated the Lake Dufault division in western Quebec. The mill treated 562,000 tons of ore containing 3.16% copper and 4.39% zinc, mostly from the Millenbach mines, and produced 19,109 tons of zinc in concentrates. The Norbec mine will be mined out during 1973, and thereafter production will come from the Millenbach mine and the Norbec stockpile. Ore reserves at yearend were 2,835,000 tons with an average grade of 3.1% copper and 3.9% zinc.[61] Falconbridge's subsidiary, Sturgeon Lake Mines Ltd., completed an engineering estimate for the development of a 1,200-ton-per-day operation near the Mattagami Lake property. Ore reserves of 1,928,000 tons, 3% copper, 7.85% zinc, and 4.54 ounces of silver per ton were considered to be available for a future open pit operation.

Manitou-Barvue Mines Ltd., near Val-d'Or, has been treating copper ore from Louvem Mining Co. but has also announced plans to reopen its silver-zinc mine in Bourlamaque.

In the Eastern Townships of Quebec, the Sullivan Mining Group Ltd. operated the Cupra, D'Estrie and Weedon mines.

---

[56] Willroy Mines Ltd. 1972 Annual Report. P. 2.

[57] Selection Trust, Ltd. 1972 Annual Report. Mar. 31, 1972, p. 26.

[58] Mattagami Lake Mines. 1972 Annual Report. Pp. 5–6.

[59] Page 14 of work cited in footnote 54.

[60] Page 4 of work cited in footnote 12.

[61] Page 30 of work cited in footnote 44.

The group produced 9,115 tons of zinc in fiscal 1972, along with copper, cadmium, and bismuth. Sullivan's Nigadoo River Mines Ltd. subsidiary closed its mine and mill in New Brunswick in January 1972.

The Brunswick Mining & Smelting Corp. Ltd., 64% owned by Noranda, accounted for the major part of New Brunswick zinc mine production. The No. 12 mine and No. 6 mine together produced 3,257,600 tons of ore containing 9.92% combined lead and zinc.[62] Part of the zinc concentrates were treated in the Belledune smelter, but in January the conversion of the Imperial smelting process to lead smelting only was begun, and a large part of the zinc concentrates was sold abroad. An estimate of the recoverable zinc metal produced by the mines was 184,000 tons. Zinc-bearing ore reserves for the two mines were about 78,000,000 tons averaging approximately 9% zinc, 3.7% lead, 2.7 ounces of silver per ton, and 0.3% copper.

Heath Steele Mines Ltd., owned by AMAX, was the only other zinc producer in New Brunswick. During 1972, 836,000 tons of ore was mined yielding 48,000 tons of zinc concentrate, 22,000 tons of lead concentrate, and 23,000 tons of copper concentrate.[63] Concentrates were shipped to the United States and Europe; estimated zinc content was 23,000 tons.

Newfoundland had one substantial zinc producer, the Buchans mine of ASARCO. Production of lead, zinc, and silver was almost double that of 1971; 30,000 tons of zinc, 17,800 tons of lead and 959,000 ounces of silver.[64] Ore reserves were determined sufficient for 6 years production based on present costs and prices.

Zinc smelter production increased in Canada during 1972 as a combined result of near-capacity utilization of existing facilities and the new facility of Ecstall Mining Ltd. (Texasgulf) coming onstream as scheduled in 1972. Brunswick Mining & Smelting Corp. ceased production of zinc metal during 1972 as the Imperial type smelter at Belledune, New Brunswick, was converted to a lead smelter in January. Canadian Electrolytic Zinc announced plans to expand its Valleyfield plant from the current capacity of 140,000 tons per year to 225,000 tons per year by 1975.[65] Cominco started construction on a battery of electrolytic zinc cells that will add 10,000 tons per year of refined zinc at the Trail operations.[66] Cominco's production was held back in July 1972 by a 1-month strike.

A summary of Canadian slab zinc production is given in the following tabulation:

Company	Current capacity	Production in 1972, short tons	Planned capacity in 1973–75, short tons per year
Canadian Electrolytic Zinc Ltd., Valleyfield, Quebec	140,000	145,000	225,000
Cominco Ltd., Trail, British Columbia	295,000	243,000	305,000
Hudson Bay Mining & Smelting Co. Ltd., Flin Flon, Manitoba	79,000	77,023	79,000
Ecstall Mining Ltd., Timmins, Ontario	120,000	60,100	150,000
Total	634,000	525,123	759,000

Germany, West.—West German mines produced ore containing 134,658 tons of zinc, and West German smelters and refineries turned out 395,000 tons of zinc, including secondary and remelted products, a 37% increase from the total metal production of 1971. The new Preussag electrolytic zinc refinery at Nordenham contributed about 92,000 tons to the total.

Italy.—A new lead-zinc Imperial-type smelter began operation at Porto Vesme on the island of Sardinia late in the year. Output by Azienda Minerali Metallici Italiane (AMMI) Sarda, S.p.A., was expected to be about 75,000 tons per year of "Grade 4" zinc, most of which will be used to produce 66,000 tons per year of Special High grade zinc. The operation used ores from the Dell' Isola area on southwest Sardinia. Local reserves included oxide ores that were treated by a heavy-media concentrating process followed by a Waelz kiln to produce oxide that was blended with sulfide flotation concentrate to make a feed for the Imperial furnace.

Japan.—Japan had a similar experience to the United States in 1972; some of its zinc mines were closed and smelter operations curtailed by the public outcry against pollution. Japanese industrialists looked increasingly abroad for future sources of zinc concentrates. Nevertheless, the zinc smelt-

[62] Page 12 of work cited in footnote 53.
[63] Page 17 of work cited in footnote 13.
[64] Page 7–10 of work cited in footnote 3.
[65] Page 19 of work cited in footnote 53.
[66] Page 10 of work cited in footnote 14.

ing industry of Japan achieved a record production of 887,700 tons of zinc metal, leading the world in slab zinc production.

Akita Zinc Co. Ltd. planned to increase capacity of its Iijima smelter and refinery by 86,000 tons per year by June 1974, and Mitsui Mining & Smelting Co. Ltd. was considering an expansion of the order of 60,000 tons per year at its Hikoshima refinery, possibly by late 1974.[67]

Mexico.—Mine production of zinc during 1972 increased about 3% to 299,656 tons. The three metal producers, Asarco Mexicana S.A. at Rosita, Zincamex S.A. at Saltillo, and Zinc Industrial at Tlalnepantla produced about 93,000 tons of refined zinc.

Industrias Peñoles, S.A., developed sources of zinc concentrates, as well as lead, copper, and silver at its Mina Reforma and Mina La Negra. Its electrolytic zinc refinery at Torreón, with a planned annual capacity of 115,700 tons of refined zinc, was under construction and was expected to begin operation in September 1973.

Asarco Mexicana, S.A., produced 118,900 tons of zinc as metal and as content of concentrates sold during 1972, a 4% decrease from 1971 production.[68]

A proposed project for a 100,000-ton-per-year zinc refinery, possibly to be located in the State of San Luis Potosí, was under study at yearend.[69] An earlier report linked a group of Japanese mining companies and the Mexican Government in the formation of a nonferrous metal development company to start prospecting in Sonora.[70]

Netherlands.—Proposed construction of an electrolytic zinc smelter at Budel, which would have 165,000-ton-per-year capacity, was announced early in 1972. Australian Mining and Smelting Co. and Billiton will each own half; Billiton will manage the smelter.[71] The existing retort smelter at Budel produced 55,000 tons of zinc in 1972.

Peru.—Production of refined zinc by Cerro Corp. increased to 74,425 tons, a gain of 18% over production in 1971. Production of zinc in concentrates for export also increased about 31% to 115,365 tons. Cerro operations in Peru returned to a more normal level of efficiency with relatively few work interruptions in 1972 in contrast to the many strikes in 1971.[72]

Compañia Minerales Santander Inc., a subsidiary of St. Joe Minerals Corp., operated a zinc-lead mine that produced about 74,000 tons of zinc concentrates marketed by a Peruvian Government agency.[73]

The total zinc production of Peru included the 74,000 tons of Cerro refined metal production, 600 tons as sulfates, 317,000 tons of ores and concentrates for export, and 2,300 tons of zinc powder. Much of the zinc concentrate production was exported to Japan.

Poland.—Zinc production in Poland was forecast to grow from 251,000 tons in 1972 to 258,000 tons in 1975. The expansion may be accomplished by increasing the capacity of the Imperial-type smelter at Miasteczko Slaskie as the old retorting methods are replaced.[74]

South Africa, Republic of.—The Prieska copper-zinc mine in northeast Cape Province of the Republic of South Africa began trial milling in October; half of the production of zinc concentrates, estimated to be 100,000 tons annually, will go to the Zinc Corp. of South Africa Ltd. (ZINCOR) and half to the export market.[75] ZINCOR also drew concentrates from the Rosh Pinah and Berg Aukas mines in the Territory of South-West Africa. Zinc metal production by ZINCOR in 1972 exceeded 50,000 tons, and an expansion was announced to raise capacity to 69,000 tons by 1973.

Spain.—Two companies produced zinc in Spain, Asturiana del Zinc at San Juan de Nieves and Española del Cinc, S. A. at La Asomada near Cartagena, for a total metal output of about 110,000 tons. Spanish mines produced about 90% of its smelting requirements, and the discovery of new deposits in southeast Spain should allow the country to be self-sufficient within a few years.

Sweden.—The Belgian firm, Vieille Montagne, announced plans to double production of zinc concentrates at its Zinkgruvan

[67] Japan Metal Journal. V. 3, No. 3, Jan. 15, 1973, p. 3.
[68] Page 9 of work cited in footnote 3.
[69] Intermet Bulletin. V. 2, No. 3, January 1973, p. 30.
[70] U.S. Embassy, Mexico, State Department Airgram A-422, July 18, 1972, p. 12.
[71] Metals Week. V. 43, No. 20, May 15, 1972, p. 1.
[72] Cerro Corp. 1972 Annual Report. P. 10.
[73] Page 12 of work cited in footnote 7.
[74] World Mining. V. 26, No. 2, February 1973, p. 62.
[75] U.S. Consul General, Johannesburg, State Department Dispatch A-052, June 15, 1973, p. 15.

mine at Ammeberg in central Sweden. The ore was reported to contain 9% zinc and 1.5% lead and, by 1976, production should reach 660,000 tons per year of ore yielding concentrates containing 53,000 tons of zinc. Other mines in Sweden were operated by The Boliden Co. and other producers to make a total estimated production for 1972 of 121,000 tons of zinc in concentrates.

Turkey.—An agreement was signed for financing in Canada the equipment for the development of a new zinc mine and electrolytic smelter in the Zamanti Valley. Projected plant capacity was 44,000 tons of zinc annually with production ready in 1975.[76] Production of ores and concentrates from Turkish mines was 27,155 tons in 1972 including crude ore, calcined concentrates and hand-sorted ore.

Yugoslavia.—Zinc metal production in Yugoslavia was below expectation in the early part of 1972, and the final estimated slab zinc production of 53,600 tons was lower than the 58,500 tons produced in 1971. The new smelter under construction at Titov Veles was planned to produce 65,000 tons of zinc per year and will double the capacity of Yugoslavia to 130,000 tons per year. Other plants at Sabac-Zorka, Zvečan-Trepča, and Celje produced in the range of 20,000 to 40,000 tons annually. Yugoslavian mines produced about 106,600 tons of zinc in concentrates in 1972.

TECHNOLOGY

Zinc Abstracts, a monthly publication, prepared jointly by the Zinc Development Association, 34 Berkeley Square, London, and the Zinc Institute, Inc., 292 Madison Avenue, New York, N.Y. 10017, provides an extensive review of current world literature on the uses of zinc and its products. The abstracts are provided free of charge to bona fide inquirers from the Zinc Institute, Inc.

The International Lead Zinc Research Organization, Inc. (ILZRO), reviews progress twice a year on lead and zinc research and development programs conducted under the direction of ILZRO. The Research Digests, which review the projects, are also available from the Zinc Institute, Inc.

Research was conducted by the Bureau of Mines during the year concerning processing lead-zinc concentrates, recovery and uses of secondary copper and zinc, and changes in the zinc supply-demand pattern. Several reports of investigations and professional papers were published by the Bureau of Mines and the Geological Survey.[77]

---

[76] World Mining. V. 26, No. 1, January 1973, p. 66.

[77] Barnard, P. G., A. G. Starliper, W. M. Dressel, and M. M. Fine. Recycling of Steelmaking Dusts. BuMines TPR 52, 1972, 10 pp.

Cole, E. R., L. W. Higley, and J. L. Holman. Lowering the Tin Content of Secondary Leaded Tin-Bronze by Replacement With Lead or Zinc. BuMines RI 7659, 1972, 12 pp.

Daellenbach, C. B., and W. M. Mahan. Copper-Zinc Removal From Scrap Iron Oxide by Pelletization-Chloridization. Proc. 3d Mineral Waste Utilization Symp., Chicago, Ill., Mar. 14–16, 1972. IIT Research Institute, Chicago, Ill., 1972, pp. 113–120.

Froisland, L. J., K. C. Dean, and C. J. Chindgren. Upgrading Junk Auto Shredder Rejects. BuMines TPR 53, 1972, 11 pp.

Kelley, J. E., H. M. Harris, and P. A. Romans. Analysis of Zinc Smelter Condensers by Color Microscope Scanning. Metallography, v. 5, No. 5, May 1972, pp. 59–68.

Neumeier, L. A., and J. S. Risbeck. Creep and Other Properties of Zinc-Copper-Titanium Alloys Annealed After Rolling. BuMines RI 7643, 1972, 31 pp.

Powell, H. E., H. Fukubayashi, L. W. Higley, and L. L. Smith. Recovery of Zinc, Copper, and Lead-Tin Mixtures From Brass Smelter Flue Dusts. BuMines RI 7637, 1972, 8 pp.

Freedman, J. Geochemical Prospecting for Zinc, Lead, Copper, and Silver, Lancaster Valley, Southeastern Pennsylvania. U.S. Geol. Survey Bull. 1314–C, 1972, pp. C1–C49.

Table 2.—Mine production of recoverable zinc in the United States, by State

(Short tons)

State	1968	1969	1970	1971	1972
Arizona	5,441	9,039	9,618	7,761	10,111
California	3,525	3,327	3,514	3,003	1,202
Colorado	50,258	53,715	56,694	61,181	63,801
Idaho	57,248	55,900	41,052	45,078	38,647
Illinois	18,182	13,765	16,797	12,706	11,378
Kansas	3,012	1,900	1,186	--	--
Kentucky	4,603	4,988	4,189	5,268	1,780
Maine	5,099	7,639	9,114	5,850	5,820
Missouri	12,301	41,099	50,721	48,215	61,923
Montana	3,778	6,143	1,457	361	12
Nevada	2,104	941	127	71	--
New Jersey	25,668	25,076	28,683	29,977	38,096
New Mexico	18,686	24,308	16,601	13,959	12,735
New York	66,194	58,728	58,577	63,420	60,749
Oklahoma	6,921	2,744	2,650	--	--
Pennsylvania	30,382	33,035	29,554	27,438	18,344
South Dakota	--	--	1	--	--
Tennessee	124,039	124,532	118,260	119,295	101,722
Utah	33,153	34,902	34,688	25,701	21,853
Virginia	19,257	18,704	18,063	16,829	16,789
Washington	13,884	9,738	11,956	5,782	6,483
Wisconsin	25,711	22,901	20,634	10,645	6,873
Other States	--	--	--	3	--
Total	529,446	553,124	534,136	502,543	478,318

Table 3.—Mine production of recoverable zinc in the United States, by month

(Short tons)

Month	1971	1972	Month	1971	1972
January	43,654	37,747	August	41,009	40,130
February	42,538	40,087	September	39,329	38,262
March	44,959	45,579	October	40,769	40,880
April	42,754	41,704	November	41,803	38,079
May	43,869	44,007	December	39,995	33,609
June	43,880	41,905			
July	37,984	36,329	Total	502,543	478,318

Table 4.—Production of zinc and lead in the United States in 1972, 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	--	--	--	--	--	--	(1)	(1)	(1)
California	[2]14,560	[2]1,010	[2]553	--	--	--	2,817	192	600
Colorado	249,098	25,456	3,183	--	--	--	509,694	25,350	16,721
Idaho	--	--	--	256,793	2,273	25,237	683,401	35,821	35,166
Maine	50,850	3,783	85	--	--	--	--	--	--
Missouri	--	--	--	8,485,769	61,923	489,397	--	--	--
Montana	--	--	--	119	--	19	--	--	--
Nevada	--	--	--	--	--	--	--	--	--
New Jersey	210,768	38,096	--	--	--	--	--	--	--
New Mexico	--	--	--	--	--	--	138,273	12,421	3,571
New York	852,453	60,749	1,089	--	--	--	--	--	--
Pennsylvania	435,277	18,344	--	--	--	--	--	--	--
Tennessee	3,522,626	96,433	--	--	--	--	--	--	--
Utah	--	--	--	--	--	--	191,119	21,264	17,175
Virginia	638,929	16,789	3,441	--	--	--	--	--	--
Washington	--	--	--	--	--	--	217,383	6,483	2,566
Wisconsin	293,465	6,873	757	--	--	--	--	--	--
Other States	218,867	6,907	644	--	--	--	--	--	--
Total	6,486,893	274,440	9,752	8,742,681	64,196	514,653	1,742,687	101,531	75,799
Percent of total zinc-lead	--	57	2	--	14	83	--	21	12

See footnotes at end of table.

Table 4.—Production of zinc and lead in the United States in 1972, 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	[2]100,172	[2]10,071	[2]667	53,194,607	40	1,096	53,294,779	10,111	1,763
California	--	--	--	(2)	(2)	(2)	17,377	1,202	1,153
Colorado	401,646	11,481	9,594	112,568	1,514	1,848	1,273,006	63,801	31,346
Idaho	--	--	--	331,046	553	1,004	1,271,240	38,647	61,407
Maine	107,952	2,037	--	--	--	--	158,802	5,820	85
Missouri	--	--	--	--	--	--	8,485,769	61,923	489,397
Montana	--	--	--	13,323	12	268	13,442	12	287
Nevada	--	--	--	159	--	(4)	159	--	(4)
New Jersey	--	--	--	--	--	--	210,768	38,096	--
New Mexico	--	--	--	2,176,670	314	11	2,314,943	12,735	3,582
New York	--	--	--	--	--	--	852,453	60,749	1,089
Pennsylvania	--	--	--	--	--	--	435,277	18,344	--
Tennessee	1,762,000	5,289	--	--	--	--	5,284,626	101,722	--
Utah	114,604	589	3,531	--	--	--	305,723	21,853	20,706
Virginia	--	--	--	--	--	--	638,929	16,789	3,441
Washington	--	--	--	66,131	--	1	283,514	6,483	2,567
Wisconsin	--	--	--	--	--	--	293,465	6,873	757
Other States	--	--	--	228,922	6,251	691	447,789	13,158	1,335
Total	2,486,374	29,467	13,792	56,123,426	8,684	4,919	75,582,061	478,318	618,915
Percent of total zinc-lead	--	6	2	--	2	1	--	100	100

[1] Zinc-lead, copper-zinc, copper-lead, and copper-zinc-lead ores combined to avoid disclosing individual company confidential data.
[2] Zinc ore and ore from all other sources combined to avoid disclosing individual company confidential data.
[3] Lead and zinc recovered from copper, gold, silver, and fluorspar ores, and from mill tailings and miscellaneous cleanups.
[4] Less than ½ unit.

Table 5.—Twenty-five leading zinc-producing mines in the United States in 1972, 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 Mo.	Lead ore.
3	Sterling Hill	Sussex, N.J.	New Jersey Zinc Co.	Zinc ore.
4	Eagle	Eagle, Colo.	do	Do.
5	Young	Jefferson, Tenn.	American Smelting & Refining Co.	Do.
6	Burgin	Utah, Utah	Kennecott Copper Corp.	Lead-zinc ore.
7	New Market	Jefferson, Tenn.	American Smelting & Refining Co.	Zinc ore.
8	Friedensville	LeHigh, Pa.	New Jersey Zinc Co.	Do.
9	Star Unit	Shoshone, Idaho	Bunker Hill Co. and Hecla Mining Co.	Lead-zinc ore.
10	Austinville and Ivanhoe	Wythe, Va.	New Jersey Zinc Co.	Zinc ore.
11	Bunker Hill	Shoshone, Idaho	Bunker Hill Co.	Lead-zinc ore.
12	Immel	Knox, Tenn.	American Smelting & Refining Co.	Zinc ore.
13	Zinc Mine Works	Jefferson, Tenn.	U.S. Steel Corp.	Do.
14	Edwards	St. Lawrence, N.Y.	St. Joe Minerals Corp.	Do.
15	Jefferson City	Jefferson, Tenn.	New Jersey Zinc Co.	Do.
16	Ground Hog	Grant, N. Mex.	American Smelting & Refining Co.	Lead-zinc ore.
17	Leadville Unit	Lake, Colo.	do	Do.
18	Idarado	San Miguel, Colo.	Idarado Mining Co.	Copper-lead-zinc ore.
19	Bruce	Yavapai, Ariz.	Cyprus Mines Corp.	Copper-zinc ore.
20	Sunnyside	San Juan, Colo.	Standard Metals Corp.	Lead-zinc ore.
21	Shullsburg	Lafayette, Wis.	Eagle-Picher Industries, Inc.	Zinc ore.
22	Pend Oreille	Pend Oreille, Wash.	Pend Oreille Mines & Metals Co	Lead-zinc ore.
23	Flat Gap [1]	Hancock, Tenn.	New Jersey Zinc Co.	Zinc ore.
24	Ozark	Reynolds, Mo.	Ozark Lead Co.	Lead ore.
25	Fletcher	do	St. Joe Minerals Corp.	Do.

[1] Closed October 1, 1972.

Table 6.—Primary and redistilled secondary slab zinc produced in the United States

(Short tons)

	1968	1969	1970	1971	1972
Primary:					
From domestic ores	499,491	458,754	403,953	403,750	400,969
From foreign ores	521,400	581,843	473,858	362,683	232,211
Total	1,020,891	1,040,597	877,811	766,433	633,180
Redistilled secondary	79,865	70,553	77,156	80,923	73,718
Total (excludes zinc recovered by remelting)	1,100,756	1,111,150	954,967	847,356	706,898

Table 7.—Distilled and electrolytic zinc, primary and secondary, produced in the United States, by method of reduction

(Short tons)

Method of reduction	1968	1969	1970	1971	1972
Electrolytic primary	398,265	453,539	393,280	321,517	259,816
Distilled	622,626	587,058	484,531	444,916	373,364
Redistilled secondary:					
At primary smelters	67,101	60,607	65,776	68,612	63,034
At secondary smelters	12,764	9,946	11,380	12,311	10,684
Total	1,100,756	1,111,150	954,967	847,356	706,898

Table 8.—Distilled and electrolytic zinc, primary and secondary, produced in the United States, by grade

(Short tons)

Grade	1968	1969	1970	1971	1972
Special high	449,659	468,792	401,273	367,609	310,074
High	117,224	136,416	109,025	73,314	44,782
Intermediate	56,686	57,180	52,480	58,240	43,353
Brass special	75,840	89,306	71,811	71,100	76,954
Prime western	401,347	359,456	320,378	277,093	231,735
Total	1,100,756	1,111,150	954,967	847,356	706,898

Table 9.—Primary slab zinc produced in the United States, by State where smelted

(Short tons)

State	1968	1969	1970	1971	1972
Idaho	102,946	105,700	95,637	94,012	101,743
Illinois	119,657	131,243	110,835	46,389	--
Montana	142,929	174,034	148,697	115,480	69,754
Oklahoma	172,174	143,575	124,811	126,908	114,162
Pennsylvania [1]	302,884	286,164	222,096	228,651	210,860
Texas	180,301	199,881	175,735	154,993	136,661
Total	1,020,891	1,040,597	877,811	766,433	633,180

[1] Prior to 1972, included West Virginia.

Table 10.—Primary slab zinc plants by group capacity in the United States in 1972

Type of plant	Plant location	Slab zinc capacity (short tons)
Electrolytic plants:		
American Smelting & Refining Co	Corpus Christi, Tex	209,000
The Anaconda Company [1]	Great Falls, Mont	
The Bunker Hill Co	Kellogg, Idaho	
Horizontal-retort plants:		512,500
American Smelting & Refining Co	Amarillo, Tex	
Blackwell Zinc Co., American Metal Climax, Inc	Blackwell, Okla	
National Zinc Co	Bartlesville, Okla	
Vertical-retort plants:		
The New Jersey Zinc Co	Palmerton, Pa	
St. Joe Minerals Corp	Josephtown, Pa	

[1] Zinc operations ended August 4, 1972.

Table 11.—Secondary slab zinc plants, by group capacity in the United States in 1972

Company	Plant location	Slab zinc capacity (short tons)
American Smelting & Refining Co	Sand Springs, Okla	34,040
Do	Trenton, N.J	
American Zinc Co	Hillsboro, Ill	
Apex Smelting Co	Chicago, Ill	
Arco Die Cast Metals Co	Detroit, Mich	
W. J. Bullock, Inc	Fairfield, Ala	
Gulf Reduction Co	Houston, Tex	
H. Kramer Co	El Segundo, Calif	
Pacific Smelting Co	Torrance, Calif	
Sandoval Zinc Co	Sandoval, Ill	

Table 12.—Stocks and consumption of new and old zinc scrap in the United States in 1972

(Short tons, gross weight)

Class of consumer and type of scrap	Stocks Jan. 1 [1]	Receipts	Consumption			Stocks Dec. 31
			New scrap	Old scrap	Total	
Smelters and distillers:						
New clippings	91	553	591	--	591	53
Old zinc	1,151	5,431	--	6,112	6,112	470
Engravers' plates	307	2,887	--	2,932	2,932	262
Skimmings and ashes	10,138	59,621	62,278	--	62,278	7,481
Sal skimmings	48	19	--	--	--	67
Die-cast skimmings	2,111	7,500	7,482	--	7,482	2,129
Galvanizers' dross	22,977	69,471	75,768	--	75,768	16,680
Diecastings	4,059	37,416	--	39,347	39,347	2,128
Rod and die scrap	568	4,091	--	4,552	4,552	107
Flue dust	1,802	4,455	4,887	--	4,887	1,370
Chemical residues	5,604	7,100	12,704	--	12,704	--
Total	48,856	198,544	163,710	52,943	216,653	30,747
Chemical plant, foundries, and other manufacturers:						
New clippings	4	17	19	--	19	2
Old zinc	3	11	--	13	13	1
Engravers' plates	--	--	--	--	--	--
Skimmings and ashes	2,253	12,199	9,782	--	9,782	4,670
Sal skimmings	5,942	8,718	7,717	--	7,717	6,943
Die-cast skimmings	--	240	--	--	--	240
Galvanizers' dross	--	--	--	--	--	--
Diecastings	8	476	--	447	447	37
Rod and die scrap	4	60	--	60	60	4
Flue dust	274	3,620	3,665	--	3,665	229
Chemical residues	3,294	28,362	31,160	--	31,160	496
Total	11,782	53,703	52,343	520	52,863	12,622
All classes of consumers:						
New clippings	95	570	610	--	610	55
Old zinc	1,154	5,442	--	6,125	6,125	471
Engravers' plates	307	2,887	--	2,932	2,932	262
Skimmings and ashes	12,391	71,820	72,060	--	72,060	12,151
Sal skimmings	5,990	8,737	7,717	--	7,717	7,010
Die-cast skimmings	2,111	7,740	7,482	--	7,482	2,369
Galvanizers' dross	22,977	69,471	75,768	--	75,768	16,680
Diecastings	4,067	37,892	--	39,794	39,794	2,165
Rod and die scrap	572	4,151	--	4,612	4,612	111
Flue dust	2,076	8,075	8,552	--	8,552	1,599
Chemical residues	8,898	35,462	43,864	--	43,864	496
Total	60,638	252,247	216,053	53,463	269,516	43,369

[1] Figures partly revised.

Table 13.—Production of zinc products from zinc-base scrap in the United States

(Short tons)

Product	1968	1969	1970	1971	1972
Redistilled slab zinc	79,865	70,553	77,156	80,923	90,297
Zinc dust	37,903	33,747	29,605	29,095	40,569
Remelt spelter	3,580	3,978	3,494	1,590	5,850
Remelt die-cast slab	14,570	16,979	16,686	18,339	13,555
Zinc-die and diecasting alloys	4,128	4,401	4,361	3,316	3,927
Galvanizing stocks	2,107	1,849	762	633	872
Secondary zinc in chemical products	45,654	45,298	r 42,238	r 45,312	50,047

r Revised.

Table 14.—Zinc recovered from scrap processed in the United States, by kind of scrap and form of recovery

(Short tons)

Kind of scrap	1971	1972	Form of recovery	1971	1972
New scrap:			As metal:		
Zinc-base	140,854	145,620	By distillation:		
Copper-base	135,201	158,834	Slab zinc [1]	79,754	88,988
Aluminum-base	2,833	3,649	Zinc dust	28,542	40,123
Magnesium-base	222	281	By remelting	2,127	6,674
Total	279,110	308,384	Total	110,423	135,785
Old scrap:			In zinc-base alloys	24,307	16,480
Zinc-base	44,876	42,998	In brass and bronze	r 171,947	177,377
Copper-base	31,308	32,456	In aluminum-base alloys	6,535	7,638
Aluminum-base	3,587	3,854	In magnesium-base alloys	627	434
Magnesium-base	272	69	In chemical products:		
			Zinc oxide (lead-free)	r 22,181	25,897
Total	80,043	79,377	Zinc sulfate	10,335	11,076
			Zinc chloride	10,111	11,126
Grand total	359,153	387,761	Miscellaneous	2,687	1,948
			Total	248,730	251,976
			Grand total	359,153	387,761

r Revised.
[1] Includes zinc content of redistilled slab made from remelt die-cast slab.

Table 15.—Zinc dust produced in the United States

Year	Quantity (short tons)	Value	
		Total (thousands)	Average per pound
1968	61,566	$22,041	$0.179
1969	55,055	21,361	.194
1970	51,136	20,045	.196
1971	50,259	19,691	.196
1972	59,358	24,669	.208

Table 16.—Consumption of zinc in the United States

(Short tons)

	1968	1969	1970	1971	1972
Slab zinc	1,350,656	1,385,380	1,186,951	1,254,059	1,418,349
Ores (recoverable zinc content) [1]	124,109	126,712	124,781	119,254	118,305
Secondary (recoverable zinc content) [2]	270,592	302,075	259,864	r 277,381	292,099
Total	1,745,357	1,814,167	1,571,596	r 1,650,694	1,828,753

r Revised.
[1] Includes ore used directly in galvanizing.
[2] Excludes redistilled slab and remelt zinc.

Table 17.—Slab zinc consumption in the United States, by industry use

(Short tons)

Industry and product	1968	1969	1970	1971	1972
Galvanizing:					
Sheet and strip	273,276	268,682	253,155	255,335	294,205
Wire and wire rope	36,089	32,348	30,857	29,895	30,769
Tubes and pipe	63,621	65,898	64,479	65,122	64,549
Fittings (for tube and pipe)	13,801	11,418	9,498	10,240	11,106
Tanks and containers	3,815	5,561	3,924	2,759	3,645
Structural shapes	20,238	19,454	18,761	18,589	20,302
Fasteners	4,826	5,536	5,318	5,159	4,310
Pole-line hardware	9,050	9,409	9,938	8,358	8,437
Fencing, wire, cloth, and netting	15,984	17,984	18,114	20,232	21,995
Other and unspecified uses	58,074	57,091	60,205	59,063	58,886
Total	498,774	493,381	474,249	474,752	518,204
Brass products:					
Sheet, strip, and plate	86,185	90,777	61,672	78,929	105,405
Rod and wire	49,888	56,989	41,459	46,514	63,143
Tube	9,818	10,928	9,086	9,399	8,886
Castings and billets	2,286	5,958	4,606	4,479	6,840
Copper-base ingots	12,153	13,642	9,946	10,440	7,137
Other copper-base products	1,576	1,175	978	725	736
Total	161,906	179,469	127,747	150,486	192,147
Zinc-base alloys:					
Diecasting alloy	551,896	565,839	453,490	504,823	566,932
Dies and rod alloy	807	504	87	270	56
Slush and sandcasting alloy	10,243	10,048	10,059	11,018	12,773
Total	562,946	576,391	463,636	516,111	579,761
Rolled zinc	48,943	48,650	41,065	38,852	45,216
Zinc oxide	34,937	41,447	43,829	40,043	51,992
Other uses:					
Light-metal alloys	8,422	7,562	3,985	4,575	6,300
Other [1]	34,728	38,480	32,440	29,240	24,729
Total	43,150	46,042	36,425	33,815	31,029
Grand total	1,350,656	1,385,380	1,186,951	1,254,059	1,418,349

[1] Includes zinc used in making zinc dust, wet batteries, desilverizing lead, bronze powder, alloys, chemicals, castings, and miscellaneous uses not elsewhere mentioned.

Table 18.—Slab zinc consumption in the United States in 1972, by grade and industry use

(Short tons)

Industry	Special high grade	High grade	Intermediate	Brass special	Prime [1] western	Remelt	Total
Galvanizing	30,585	24,972	70	120,855	341,106	616	518,204
Brass and bronze	38,474	106,317	133	9,034	38,099	90	192,147
Zinc-base alloys	569,460	9,074	11	181	639	396	579,761
Rolled zinc	20,384	--	18,967	--	5,865	--	45,216
Zinc oxide	21,344	--	--	--	30,648	--	51,992
Other	17,334	3,865	809	9	9,002	10	31,029
Total	697,581	144,228	19,990	130,079	425,359	1,112	1,418,349

[1] Includes select grade.

Table 19.—Rolled zinc produced and quantity available for consumption in the United States

	1971			1972		
	Short tons	Value		Short tons	Value	
		Total (thousands)	Average per pound		Total (thousands)	Average per pound
Production: [1]						
Photoengraving plate	11,290	$8,259	$0.390	13,418	$10,118	$0.377
Sheet zinc less than 0.375 inch thick	W	W	W	--	--	--
Strip and foil	25,342	13,656	.269	28,189	17,100	.303
Total rolled zinc [2]	38,263	23,399	.306	45,216	28,820	.319
Exports	1,686	1,486	.441	2,419	2,138	.442
Imports	509	237	.233	485	310	.320
Available for consumption	38,390	--	--	43,057	--	--

W Withheld to avoid disclosing individual company confidential data; included in total.
[1] Figures represent net production. In addition, 20,276 tons in 1971 and 41,764 tons in 1972 were rerolled from scrap originating in fabricating plants operating in connection with zinc-rolling mills.
[2] Includes other plate over 0.375 inch thick rod and wire, and strip and foil. Bureau of Mines not at liberty to publish separately.

Table 20.—Slab zinc consumption in the United States in 1972, by industry and State

(Short tons)

State	Galvanizers	Brass mills [1]	Diecasters [2]	Other [3]	Total
Alabama	46,731	W	--	W	47,890
Arizona	W	--	--	--	W
California	32,734	3,677	21,767	1,494	59,672
Colorado	W	W	W	W	4,058
Connecticut	3,523	38,291	W	W	47,140
Delaware	W	W	W	--	W
Florida	W	--	W	--	4,640
Georgia	W	--	W	--	W
Hawaii	W	--	--	--	W
Idaho	--	--	28,178	756	28,934
Illinois	49,164	28,604	95,080	12,374	185,222
Indiana	59,989	W	W	W	141,969
Iowa	W	--	--	W	1,471
Kansas	--	W	W	--	W
Kentucky	W	W	--	W	W
Louisiana	1,955	--	--	--	1,955
Maine	W	--	--	--	W
Maryland	W	W	--	--	W
Massachusetts	2,493	W	--	W	7,597
Michigan	W	20,533	135,645	W	162,037
Minnesota	W	--	W	--	2,542
Mississippi	W	--	--	--	W
Missouri	8,033	W	W	W	14,737
Nebraska	W	W	--	W	3,565
New Hampshire	--	W	--	--	W
New Jersey	W	5,956	W	2,936	17,792
New York	12,733	W	77,922	W	110,665
North Carolina	--	--	W	W	W
Ohio	101,952	W	83,054	W	195,169
Oklahoma	8,322	--	W	W	12,824
Oregon	W	W	W	--	1,059
Pennsylvania	70,193	W	26,721	W	175,798
Rhode Island	W	W	--	W	561
South Carolina	W	--	--	--	W
Tennessee	W	--	W	W	29,254
Texas	14,468	W	W	W	49,577
Utah	W	W	--	--	W
Virginia	W	W	W	W	238
Washington	W	--	--	W	2,121
West Virginia	W	W	--	W	33,559
Wisconsin	1,426	W	W	W	17,023
Undistributed	103,872	94,996	110,998	110,667	58,168
Total [4]	517,588	192,057	579,365	128,227	1,417,237

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 21.—Production and shipments of zinc pigments and compounds[1] in the United States

Pigment or compound	1971 Production (short tons)	1971 Shipments Quantity (short tons)	1971 Shipments Value[2] Total (thousands)	1971 Shipments Value[2] Average per ton	1972 Production (short tons)	1972 Shipments Quantity (short tons)	1972 Shipments Value[2] Total (thousands)	1972 Shipments Value[2] Average per ton
Zinc oxide[3]	214,952	227,503	$72,910	$320	237,015	245,867	$84,244	$343
Zinc sulfate	45,929	49,303	6,333	128	38,897	39,595	5,220	132

[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 22.—Zinc content of zinc pigments[1] and compounds produced by domestic manufacturers, by source

(Short tons)

Pigment or compound	1971 Ore Domestic	1971 Ore Foreign	1971 Slab zinc	1971 Secondary material	1971 Total zinc in pigments and compounds	1972 Ore Domestic	1972 Ore Foreign	1972 Slab zinc	1972 Secondary material	1972 Total zinc in pigments and compounds
Zinc oxide	79,732	25,230	r40,656	r26,444	172,062	89,308	19,825	52,117	31,106	192,356
Zinc sulfate	1,891	3,816	--	10,262	15,969	3,788	1,325	--	8,280	13,393

r Revised.
[1] Excludes leaded zinc oxide, zinc sulfide, and lithopone; figures withheld to avoid disclosing individual company confidential data.

Table 23.—Distribution of zinc oxide shipments, by industry[1]

(Short tons)

Industry	1968	1969	1970	1971	1972
Rubber	111,797	115,988	111,421	124,472	129,170
Paints	25,864	25,170	21,894	24,990	27,244
Ceramics	10,226	9,469	9,011	8,125	10,702
Chemicals	22,769	22,775	19,435	18,901	22,781
Agriculture	5,044	4,007	2,246	1,615	1,101
Photocopying	21,564	27,566	31,850	34,504	36,190
Other	16,562	14,748	17,426	14,896	18,679
Total	213,826	219,723	213,283	227,503	245,867

[1] For information on leaded zinc oxide shipments prior to 1971, refer to the 1970 Minerals Yearbook.

Table 24.—Distribution of zinc sulfate shipments, by industry

(Short tons)

Year	Agriculture Gross weight	Agriculture Dry basis	Other[1] Gross weight	Other[1] Dry basis	Total Gross weight	Total Dry basis
1968	20,472	17,631	39,175	30,265	59,647	47,896
1969	19,029	16,424	45,563	33,861	64,592	50,285
1970	17,213	14,803	36,856	26,572	54,069	41,375
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

[1] Includes rayon; Bureau of Mines not at liberty to publish separately.

Table 25.—Stocks at zinc-reduction plants in the United States, December 31

(Short tons)

	1968	1969	1970	1971	1972
At primary reduction plants	64,695	64,903	97,576	r 40,745	19,956
At secondary distilling plants	684	885	738	r 475	1,225
Total	65,379	65,788	98,314	r 41,220	21,181

r Revised.

Table 26.—Consumers stocks of slab zinc at plants, December 31, by grade

(Short tons)

Date	Special high grade	High grade	Inter-mediate	Brass special	Prime western	Remelt	Total
Dec. 31, 1971 r	39,075	4,513	605	10,675	36,490	165	91,523
Dec. 31, 1972	46,559	10,904	578	17,267	50,741	92	126,141

r Revised.

Table 27.—Average monthly quoted prices of common zinc (prompt delivery or spot), London and the United States [1]

(Metallic zinc, cents per pound)

Month	1971			1972		
	United States	LME [2] cash	European producer	United States	LME [2] cash	European producer
January	15.00	12.91	13.96	17.00	17.21	17.49
February	15.00	12.45	14.03	17.00	17.66	17.71
March	15.07	12.99	14.04	17.30	17.99	17.81
April	15.50	12.98	14.03	17.74	17.90	17.76
May	15.77	13.18	14.04	17.88	17.51	17.78
June	16.00	14.13	15.25	18.00	16.77	17.48
July	16.19	14.54	16.46	18.00	16.49	17.75
August	17.00	14.57	16.56	18.00	16.48	17.78
September	17.00	14.05	16.80	18.00	16.69	17.72
October	17.00	15.25	16.95	18.00	16.48	17.38
November	17.00	15.61	16.96	18.00	17.16	17.31
December	17.00	16.27	17.19	18.11	17.00	18.40
Average for year	16.13	14.08	15.52	17.75	17.13	17.73

[1] Source: Metals Week.
[2] London Metal Exchange.

Table 28.—U.S. exports of slab and sheet zinc, by country

Destination	1970 Quantity (short tons)	1970 Value (thousands)	1971 Quantity (short tons)	1971 Value (thousands)	1972 Quantity (short tons)	1972 Value (thousands)
Slabs, pigs, blocks:						
Canada	69	$34	233	$63	349	$70
Chile	29	10	8	3	10	5
Dominican Republic	--	--	2	1	60	23
Germany, West	22	4	4	2	--	--
Honduras	20	8	5	2	--	--
Liberia	21	9	6	2	--	--
Netherlands	21	4	--	--	--	--
Spain	41	7	41	7	--	--
Turkey	--	--	3,024	738	--	--
United Kingdom	15	16	10,005	1,501	3,786	568
Venezuela	33	12	--	--	110	42
Other	17	10	r 18	r 18	9	6
Total	288	114	13,346	2,337	4,324	714
Sheets, plates, strips, or other forms, n.e.c.:						
Argentina	41	35	51	34	32	23
Australia	3	4	85	75	51	42
Brazil	4	6	(1)	(1)	3	4
Canada	1,006	825	1,065	946	1,329	1,194
Chile	5	5	2	2	23	16
Colombia	17	18	4	4	7	5
Costa Rica	10	9	14	13	12	11
Dominican Republic	8	3	51	20	15	12
El Salvador	10	10	14	13	10	10
France	(1)	1	(1)	(1)	33	39
Ireland	--	--	16	17	20	23
Israel	1	1	28	19	84	60
Jamaica	12	10	13	10	26	23
Japan	1	4	1	1	20	18
Lebanon	--	--	--	--	41	31
Mexico	13	11	43	36	81	65
New Zealand	12	11	2	1	14	9
Pakistan	23	20	--	--	--	--
South Africa, Republic of	14	11	101	90	166	145
Sri Lanka (formerly Ceylon)	--	--	--	--	19	17
Taiwan	54	25	--	--	4	3
Thailand	--	--	--	--	22	13
United Kingdom	6	3	119	124	156	169
Venezuela	87	79	34	32	120	106
Other	85	82	43	49	131	100
Total	1,412	1,173	1,686	1,486	2,419	2,138

r Revised.
1 Less than ½ unit.

Table 29.—U.S. exports of zinc, by class

Year	Slabs, pigs, or blocks		Sheets, plates, strips, or other forms, n.e.c.		Zinc scrap and dross (zinc content)		Semifabricated forms, n.e.c.	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1970	288	$114	1,412	$1,173	3,112	$1,049	25,528	$5,635
1971	13,346	2,337	1,686	1,486	2,000	504	6,042	2,709
1972	4,324	714	2,419	2,138	1,446	431	6,052	3,076

Table 30.—U.S. exports of zinc pigments

Kind	1971 Quantity (short tons)	1971 Value (thousands)	1972 Quantity (short tons)	1972 Value (thousands)
Zinc oxide	6,684	$2,439	6,172	$2,306
Lithopone	545	425	1,395	458
Total	7,229	2,864	7,567	2,764

Table 31.—U.S. imports for consumption of zinc, by country

Country	1970 Quantity (short tons)	1970 Value (thousands)	1971 Quantity (short tons)	1971 Value (thousands)	1972 Quantity (short tons)	1972 Value (thousands)
ORES [1]						
Australia	1,893	$366	3,188	$720	926	$186
Bolivia	4,098	595	4,738	696	77	21
Canada	263,287	40,230	257,555	38,588	109,720	15,874
Chile	1,331	267	--	--	--	--
Germany, West	10,438	1,638	3,517	528	1,162	260
Honduras	10,001	1,342	22,486	2,934	3,680	547
Ireland	537	38	1,965	310	2,175	368
Mexico	101,871	13,430	121,016	14,925	39,282	4,530
Morocco	--	--	8,531	868	--	--
Peru	51,269	8,330	44,256	3,088	8,000	1,304
South Africa, Republic of	5,040	764	100	19	9,041	1,185
Other	1,005	164	16	2	--	--
Total	450,770	67,164	467,368	62,678	174,063	24,275
BLOCKS, PIGS, OR SLABS						
Australia	30,335	9,359	37,096	11,634	41,079	14,863
Belgium-Luxembourg	14,371	3,876	9,365	2,701	39,616	13,998
Canada	120,611	34,329	149,700	42,698	272,493	92,255
Ecuador	--	--	--	--	909	301
Finland	1,313	368	32,417	9,270	5,102	1,416
France	512	150	2,211	752	11,825	4,225
Germany, West	442	122	6,138	1,772	31,358	11,551
Japan	32,525	8,764	8,705	2,308	30,072	10,968
Mexico	7,358	1,746	10,130	2,442	8,394	2,276
Mozambique	661	170	--	--	--	--
Netherlands	200	56	18,745	5,849	14,001	5,096
Norway	1,343	395	2,205	329	--	--
Peru	31,923	9,143	24,412	7,283	30,625	9,760
Poland	7,729	2,284	2,508	729	4,418	1,584
South Africa, Republic of	--	--	4,740	1,422	--	--
Spain	--	--	5,071	1,475	1,102	381
United Kingdom	1,054	294	745	196	1,553	563
Yugoslavia	114	32	138	39	1,543	589
Zaire	6,300	1,695	8,898	2,444	22,493	6,860
Zambia	1,773	493	315	91	--	--
Other	1,568	419	r 716	r 194	60	21
Total	260,132	73,695	r 324,255	r 93,628	516,643	176,707

r Revised.

[1] Does not include zinc ores and concentrates for refining and export: 1970—Canada, 18,932 short tons ($2,748,599); Mexico, 565 short tons ($102,213); Morocco, 145 short tons ($10,918). 1971—Canada, 11,791 short tons ($1,816,250); Mexico, 14 short tons ($2,723); Peru, 1,657 short tons ($298,278); Ireland, 10 short tons ($981); Republic of South Africa, 82 short tons ($7,450). 1972—Canada, 4,787 short tons ($735,225); Mexico, 171 short tons ($27,437); Ireland, 176 short tons ($17,439); the Netherlands, 98 short tons ($17,595); Belgium-Luxembourg, 16 short tons ($2,690).

Table 32.—U.S. general imports of zinc, by country

Country	1970		1971		1972	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
ORES						
Australia	2,324	$518	2,857	$201	5,871	$239
Bolivia	2,904	439	--	--	--	--
Canada	317,992	47,153	209,084	30,027	135,534	19,483
Chile	1,056	201	--	--	--	--
Germany, West	--	--	--	--	1,162	260
Guatemala	4	1	138	13	723	130
Honduras	19,267	2,845	21,512	3,230	17,370	2,415
Ireland	--	--	3,975	657	5,978	885
Mexico	128,949	16,921	89,845	11,099	57,315	7,106
Nicaragua	--	--	--	--	10,960	1,163
Peru	48,037	7,644	15,025	2,375	15,256	2,007
South Africa, Republic of	5,096	772	61	11	4,690	779
Other	130	18	24	3	9	(1)
Total	525,759	76,512	342,521	47,616	254,868	34,467
BLOCKS, PIGS, OR SLABS						
Australia	30,335	9,359	38,552	12,056	39,623	14,441
Belgium-Luxembourg	14,371	3,876	9,365	2,701	39,616	13,998
Canada	120,611	34,329	150,868	43,050	271,130	91,826
Ecuador	--	--	--	--	909	301
Finland	1,313	368	31,702	9,348	8,583	2,572
France	512	150	2,211	752	11,825	4,225
Germany, West	3,198	886	3,661	1,085	31,358	11,551
Japan	32,525	8,764	8,705	2,308	30,072	10,968
Mexico	7,358	1,746	10,130	2,442	8,394	2,276
Mozambique	661	170	--	--	--	--
Netherlands	7,725	2,143	13,283	4,220	14,001	5,096
Norway	1,343	395	2,205	329	--	--
Peru	31,923	9,143	23,873	7,132	30,625	9,760
Poland	7,729	2,284	2,618	764	4,199	1,514
Romania	--	--	1,221	354	5,526	1,603
South Africa, Republic of	--	--	4,740	1,422	--	--
Spain	--	--	5,071	1,475	1,102	381
United Kingdom	1,054	294	800	210	1,553	563
Yugoslavia	114	32	138	39	1,543	589
Zaire	6,300	1,695	8,898	2,444	22,493	6,860
Zambia	1,773	493	315	91	--	--
Other	1,568	419	1,212	332	60	21
Total	270,413	76,546	319,568	92,554	522,612	178,545

[1] Less than ½ unit.

Table 33.—U.S. imports for consumption of zinc, by class

Year	Ore (zinc content) Quantity (short tons)	Ore (zinc content) Value (thousands)	Blocks, pigs, slabs Quantity (short tons)	Blocks, pigs, slabs Value (thousands)	Sheets, plates, strips, other forms Quantity (short tons)	Sheets, plates, strips, other forms Value (thousands)
1970	450,770	$67,164	260,132	$73,695	692	$419
1971	467,368	62,678	r 324,255	r 93,628	509	237
1972	174,063	24,275	516,643	176,707	485	310

Year	Old and worn out Quantity (short tons)	Old and worn out Value (thousands)	Dross and skimmings Quantity (short tons)	Dross and skimmings Value (thousands)	Zinc dust Quantity (short tons)	Zinc dust Value (thousands)	Total value [1] (thousands)
1970	1,497	$192	418	$92	9,359	$3,161	$144,723
1971	1,114	147	853	140	8,184	2,949	r 159,779
1972	814	235	2,068	1,935	9,197	3,822	207,284

r Revised.
[1] In addition manufactures of zinc were imported as follows: 1970—$1,276,276; 1971—$1,346,752; 1972—$2,040,029.

Table 34.—U.S. imports for consumption of zinc pigments and compounds

Kind	1971 Quantity (short tons)	1971 Value (thousands)	1972 Quantity (short tons)	1972 Value (thousands)
Zinc arsenate	r (1)	$1	1	$10
Zinc oxide	13,113	2,945	19,349	5,647
Zinc sulfide	428	142	534	206
Lithopone	81	13	84	17
Zinc chloride	1,319	266	1,490	257
Zinc sulfate	5,438	567	3,944	475
Zinc cyanide	162	116	93	70
Zinc hydrosulfite	--	--	20	7
Zinc compounds, n.s.p.f	372	137	419	202
Total	r 20,913	4,187	25,934	6,891

r Revised.
[1] Less than ½ unit.

Table 35.—Zinc: World mine production (content of ore), by country

(Short tons)

Country [1]	1970	1971	1972 p
North America:			
Canada [2]	1,365,938	1,397,246	1,410,000
Guatemala (exports)	--	558	340
Honduras	22,090	25,236	25,678
Mexico	293,655	292,081	299,656
United States	534,136	502,543	478,318
South America:			
Argentina	42,974	46,300	40,000
Bolivia [3]	51,239	49,689	46,370
Brazil	13,900	18,650	19,600
Chile	1,694	2,086	2,000
Colombia	172	123	e 94
Ecuador	140	139	e 145
Peru	329,741	427,104	394,200
Europe:			
Austria	17,314	23,229	22,575
Bulgaria	84,200	68,200	e 68,000
Czechoslovakia	11,299	e 13,000	e 13,000
Finland	69,015	56,093	54,998
France	20,481	16,689	14,661
Germany, East e	11,000	11,000	9,000
Germany, West	r 141,776	145,487	134,658
Greece	r 10,228	15,664	14,600
Hungary e	5,300	5,300	5,300
Ireland	106,366	96,500	103,000
Italy	122,000	116,700	113,075
Norway	r 11,551	11,813	17,562
Poland	205,900	213,400	215,000
Portugal	1,770	2,255	1,941
Romania (recoverable) e	43,900	43,900	44,000
Spain	108,098	96,496	98,612
Sweden	r 102,929	109,176	121,000
U.S.S.R. e	672,000	717,000	717,000
Yugoslavia	111,493	108,791	106,615
Africa:			
Algeria	18,710	17,413	24,300
Congo (Brazzaville)	100	700	e 770
Morocco	r 18,100	13,600	20,000
South Africa, Republic of	8	174	2,215
South-West Africa, Territory of [4]	51,462	48,168	38,296
Tunisia	r 13,600	13,000	12,600
Zaire	115,833	144,050	123,300
Zambia (smelter)	58,925	62,904	61,711
Asia:			
Burma	r 4,358	4,432	5,942
China, People's Republic of e	110,000	110,000	110,000
India	9,090	9,089	9,776
Iran e [5]	63,600	64,000	66,000
Japan	308,293	324,541	309,731
Korea, North e	143,000	149,000	154,000
Korea, Republic of	26,433	31,042	39,600
Philippines	3,517	4,271	5,074
Thailand (in lead-zinc ore) e	600	1,000	770
Turkey	r 26,900	26,705	27,155
Oceania:			
Australia	537,052	496,366	553,564
New Zealand	1,608	2,171	1,821
Total	r 6,023,488	6,155,074	6,157,623

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] Zinc content of concentrates.

[3] Sum of production by COMIBOL and exports by medium and small mines.

[4] Data are total of output for Rosh Pinah mine, Berg Aukas mine, and Tsumeb Corp. for years ended June 30 of that stated except for 1972; in 1972 Tsumeb Corp. data is for calendar 1972 and that for the other two properties is for year ended June 30, 1972. In the period July 1, 1971 to December 31, 1971, Tsumeb Corp. produced 3,162 short tons of zinc in concentrates, which is not included in above figures.

[5] Year beginning March 21, of year stated.

Table 36.—Zinc: World smelter production, by country

(Short tons)

Country [1]	1970	1971	1972 p
North America:			
Canada	460,663	410,030	525,400
Mexico	88,915	85,828	87,499
United States	877,811	766,433	633,180
South America:			
Argentina	r 31,600	37,000	45,000
Brazil	r 9,451	15,278	17,811
Peru	75,715	63,048	74,032
Europe:			
Austria [2]	17,657	17,603	18,604
Belgium [2]	265,918	227,950	283,700
Bulgaria [2]	83,900	86,400	93,000
Finland	61,531	70,219	89,393
France	r 246,562	241,027	289,700
Germany, East e [2]	17,000	17,000	17,000
Germany, West	r 114,300	101,300	235,500
Italy	156,618	154,128	171,695
Netherlands	50,952	45,600	55,400
Norway	r 68,022	68,963	80,851
Poland [2]	230,400	242,500	251,300
Romania e	43,900	43,900	44,000
Spain	r 97,185	94,436	109,326
U.S.S.R. e	672,000	717,000	717,000
United Kingdom	r 161,595	128,379	81,379
Yugoslavia [2]	71,676	58,543	53,617
Africa:			
South Africa, Republic of	18,174	22,584	13,923
Zaire	70,272	69,181	69,000
Zambia	58,925	62,904	61,711
Asia:			
China, People's Republic of e	110,000	110,000	110,000
India	25,805	23,443	27,808
Japan	745,437	789,660	887,700
Korea, North e	99,000	110,000	132,000
Korea, Republic of	2,535	9,925	11,815
Oceania:			
Australia	287,252	285,164	327,059
Total	r 5,320,771	5,175,426	5,615,403

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.

Zirconium and Hafnium

By Sarkis G. Ampian [1]

Zircon production and sales by domestic mining companies were about 20% greater in 1972 than in 1971. Zircon exports increased 84% from 9,429 tons in 1971 to 17,360 tons in 1972 while imports decreased 30% from 96,387 short tons in 1971 to 67,537 short tons in 1972. Exports of zirconium oxide, zirconium metal, and zirconium alloys all rose in 1972. Production of zirconium-bearing compounds for chemicals and refractories also increased. Zircon consumption by foundries declined nearly 20%, from 116,000 short tons in 1971 to 92,000 tons in 1972. However, foundry consumption of zircon was increasing at yearend.

Legislation and Government Programs.—The Statistical Supplement to the Stockpile Report to Congress, December 31, 1972, showed no objectives for zirconium and hafnium materials. Stocks of 15,998 tons of Brazilian baddeleyite and 1 ton of zirconium metal powder are in excess. The U.S. Atomic Energy Commission (AEC) had an inventory as of June 30, 1972, of approximately 1 ton of zirconium crystal bar and scrap, 1,063 tons of zirconium sponge, 84 tons of Zircaloy ingot and shapes, 2 tons of hafnium scrap, 47 tons of hafnium oxide, 1/2 ton of hafnium sponge and shapes, and 39 tons of hafnium crystal bar.

Table 1.—Salient zirconium statistics in the United States

(Short tons)

Product	1968	1969	1970	1971	1972
Zircon:					
Production	W	W	W	W	W
Exports	2,026	5,395	4,335	9,429	17,360
Imports	59,900	95,414	94,759	96,387	67,537
Consumption [e]	[1] 143,000	[1] 160,000	[1] 145,000	[1] 166,000	[1] 168,000
Stocks, yearend, dealers and consumers [2]	46,000	53,000	52,000	42,500	44,500
Zirconium oxide:					
Production [3]	3,864	5,702	4,957	10,770	12,020
Producers' stocks, yearend [3]	1,077	1,005	1,050	680	942

[e] Estimate. W Withheld to avoid disclosing individual company confidential data.
[1] Includes baddeleyite: 1968—200 tons; 1969—383 tons; 1970—355 tons; 1971—871 tons; 1972—385 tons.
[2] Excludes foundries.
[3] Excludes oxide produced by zirconium metal producers.

DOMESTIC PRODUCTION

E. I. du Pont de Nemours & Co., and Titanium Enterprises, Inc., a new producer, were the only major producers of zircon mineral concentrate in the United States. Zircon was recovered from mineral sands at the dredging and milling 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 125,000 tons per year.

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. Zirconium powder, zirconium-base alloys, and zirconium sponge metal production were relatively unchanged from those

[1] Physical scientist, Division of Nonmetallic Minerals.

reported for 1971. Approximately 5,000 tons of alloys containing from 3% to 70% zirconium was produced in 1972.

Three firms produced 45,000 tons of milled (ground) zircon, a decrease of nearly 5% from the reported 1971 production. Six companies, excluding those that produce metal, produced 12,020 tons of zirconium oxide. Oxide production in 1972 increased nearly 12% over that reported in 1971. Production of zirconium-bearing refractories totaled 43,000 tons, containing from 33% to 95% zirconium oxide.

Hafnium crystal bar, produced by several firms, amounted to 40 tons, compared with 32 tons in 1971.

CONSUMPTION AND USES

Zircon consumption in the United States in 1972 was estimated at 168,000 tons. Consumption of zircon concentrate and milled zircon was 92,000 tons for foundries, 25,000 tons for refractories, 18,000 tons for zirconium oxide, 3,000 tons for zirconium alloys (excluding zirconium-base alloys), and 30,000 tons for all other uses. Foundries

Table 2.—Producers of zirconium and hafnium materials in 1972

Company	Location	Materials
ZIRCONIUM MATERIALS		
AMAX Specialty Metals, Inc	Akron, N.Y	Ingot, sponge, scrap, powder, crystal bar.
Do	Parkersburg, W. Va	Sponge metal.
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.
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.
Do	Exton, Pa	Metal powder.
A. P. Green Refractories Co., Remmey Division	Philadelphia, Pa	Refractories.
Harbison-Walker Refractories Co	Mount Union, Pa	Do.
Harshaw Chemical Co., Inc	Cleveland, Ohio	Oxide, ceramics.
Ionarc/TAFA	Bow, N.H	Oxide.
Lava Crucible Refractories	Zelienople, Pa	Refractories.
M & T Chemicals, Inc	Andrews, S.C	Do.
Magnesium Electron, Inc	Secaucus, N.J	Alloys.
Martin Marietta Aluminum, Inc	Torrance, Calif	Scrap.
N L Industries, Inc., Titanium Alloy Manufacturing Div. (TAM).	Niagara Falls, N.Y	Milled zircon, sponge, scrap, oxide, powder, alloys, refractories, chloride.
Norton Co	Huntsville, Ala	Oxide.
Ohio Ferro-Alloys Corp	Brillant, Ohio	Alloys.
Ronson Metals Corp	Newark, N.J	Baddeleyite (oxide).
Frank Samuel & Co. Inc	New Castle, Del	Milled zircon.
Do	Camden, N.J	Do.
Sherwood Refractories Co	Cleveland, Ohio	Do.
Stauffer Chemical Co	Niagara Falls, N.Y	Chloride.
The Charles Taylor Sons Co	Cincinnati, Ohio	Refractories.
Do	South Shore, Ky	Do.
Titanium Enterprises, Inc	Green Cove Springs, Fla	Zircon.
Tizon Chemical Corp	Flemington, N.J	Oxide, other compounds.
Transelco, Inc	Dresden, N.Y	Various compounds, ceramics, alloys.
T. R. W., Inc	Cleveland, Ohio	Milled zircon.
Do	Danville, Pa	Do.
Do	Harrisburg, Pa	Do.
Union Carbide Corp	Alloy, W. Va., and Niagara Falls, N.Y.	Alloys, metal powder.
Ventron Corp	Beverly, Mass	Alloys, oxide, sponge metal.
Wah Chang Albany Corp	Albany, Oreg	Oxide, chloride, sponge metal, scrap ingot, powder, crystal bar.
Zedmark, Inc	Butler, Pa	Refractories.
Zirconium Corp. of America	Cleveland, Ohio	Oxide, refractories, ceramics.
HAFNIUM MATERIALS		
AMAX Specialty Metals, Inc	Akron, N.Y	Sponge metal, crystal bar, ingot, scrap.
Do	Parkersburg, W. Va	Sponge metal, oxide.
Nuclear Materials & Equipment Corp	Leechburg, Pa	Crystal bar.
R. M. I. Co	Ashtabula, Ohio	Sponge, crystal.
Wah Chang Albany Corp	Albany, Oreg	Oxide, sponge metal, crystal bar, ingot.

consumed 51% of the domestic zircon production. The remaining 49% was consumed by refractory, ceramic, metal, and other industries. Domestic zircon was also 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 1972 was used mostly in the manufacture of alumina-zirconia abrasives, and used also in ceramic colors, refractories, and other uses.

Preliminary Bureau of the Census figures for 1972 showed that shipments of zircon and zirconia brick and shapes, composed mostly of these materials, totaled 1.7 million brick, expressed in terms of equivalent 9-inch brick, valued at $6.2 million. In 1971, final figures for shipments were 1.9 million brick valued at $6.9 million.[2]

Dealers and other firms reported shipments of milled zircon and concentrate in 1972 to the following markets: Foundry use, 42,000 tons; refractory and chemical uses, 52,000 tons; chemical, metal, alloying, compounds, and other uses, 4,200 tons.

Zirconium metal was used in nuclear reactors, in chemical plants for corrosion-resistant material, in refractory alloys, and in photography for flashbulbs. AMAX Specialty Metals, Inc. acquired a new metal-rolling facility. The new facility will be used to produce flat products, such as plate, sheet, strip, and foil, from zirconium and molybdenum alloys and metals.

Zirconium compounds, natural and manufactured, were also used in refractories, glazes, enamels, welding rods, chemicals, and sandblasting, Zirconium chemicals were finding increasing applications in the paint, textile, and pharmaceutical industries. Ionarc/TAFA recently began streamlining its pilot commercial-scale ZrO_2 plant. This new plant was scheduled for

[2] U.S. Department of Commerce, Bureau of the Census. Refractories. Quarterly, 1972.

Table 3.—Zircon consumption in selected zirconium materials as reported by producers in the United States in 1972

(Short tons)

Use	Quantity
Zircon refractories [1]	12,000
AZS refractories [2]	13,000
Zirconia [3]	18,000
Alloys [4]	3,000
Other [5]	30,000

[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] Excludes 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 1972

(Short tons)

Use	Quantity
AZ abrasives [2]	3,000
AZS refractories [3]	2,500
Other refractories	1,000
Chemicals	300
Glazes, opacifiers, and colors	1,000

[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	1971	1972
Zircon concentrate held by dealers and consumers excluding foundries	36,000	40,000
Milled zircon held by dealers and consumers excluding foundries	r 6,500	4,500
Zirconium:		
Oxide	1,055	1,300
Sponge	426	471
Ingot	W	W
Scrap	741	722
Powder	W	W
Alloys	356	285
Refractories	8,098	9,585
Hafnium:		
Oxide	W	W
Sponge	42	25
Crystal bar	10	6

r Revised. W Withheld to avoid disclosing individual company confidential data.

completion by the summer of 1973 with a projected capacity of 1 million pounds per year of their unique plasma-produced zirconia. This highly reactive zirconia, readily soluble in sulfuric acid, was reported to be particularly suited for zirconia-based colors, chemicals, and polishes.

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.

PRICES

Published prices of zircon, zirconium oxides and chemicals, zirconium hydride, zirconium metal powder and sponge, and hafnium metal products were relatively unchanged from those of 1971. The baddeleyite price was furnished by Ronson Metals Corp.

Table 6.—Published prices of zirconium and hafnium materials in 1972

Specification of material	Price
Zircon:	
Domestic, f.o.b. Starke, Fla. (Folkston, Ga.) bags, per short ton [1]	$54.00 –$55.00
Domestic, 75% minimum quantity zircon and aluminum silicates, Starke, Fla. (Folkston, Ga.) bags, per short ton	40.00
Imported sand, containing 65% ZrO_2, c.i.f. Atlantic ports, bags, per long ton [2]	65.00 – 70.00
Domestic, granular, 30-ton lots, from works, bags, per pound [3]	.04875
Domestic, milled, 15-ton lots, from works, bags, per pound [3]	.050
Baddeleyite imported concentrate:[4]	
98%–99% ZrO_2, minus 100-mesh, c.i.f. Atlantic ports, per pound	.16 – .20
99+%, minus 325-mesh, c.i.f. Atlantic ports, ton lots, per pound	.45 – .60
Zirconium oxide:[3]	
Powder, commercial-reactor grade, drums, from work, per pound [3]	6.50 – 8.00
Chemically pure white ground, barrels or bags, works, per pound [3]	1.50
Electric fused, lump, bags, works, per pound	.505– .530
High-purity, bags, 98%–99% ZrO_2, works, ton lots, per pound	.63 – .80
Milled, bags, 5-ton lots, from works, per pound [3]	.64
Glass-polishing grade, 100-pound bags, 85%–90% ZrO_2, works, per pound [3]	.71
Opacifier grade, 100-pound bags, 85%–90% ZrO_2, per pound [3]	.42
Stabilized oxide, 100-pound bags, 91% ZrO_2, milled, per pound [3]	.80 – 1.10
Zirconium oxychloride: Crystal, cartons, 5-ton lots from works, per pound	.515
Zirconium acetate solution:[3]	
13% ZrO_2, drums, carload lots, from works, per pound	.22
22% ZrO_2, same basis	.38
Zirconium hydride:[3] Electronic grade, powder, drums, from works, per pound	14.50 – 16.00
Zirconium:	
Powder, per pound [5]	10.00
Sponge, per pound [2]	5.50 – 7.00
Sheets, strip, bars, per pound [2]	8.00 – 17.00
Hafnium:	
Sponge, per pound	75.00
Bar and plate, rolled, per pound	120.00
Nitrided	34.25

[1] E. I. du Pont de Nemours & Co. Price List. Aug. 1, 1972.
[2] Metals Week. V. 43, No. 28, July 10, 1972, p. 4.
[3] Chemical Marketing Reporter. V. 202, No. 2, July 10, 1972, p. 36.
[4] Ronson Metals Corp. Baddelyite Price List. Jan. 1, 1972.
[5] American Metal Market. V. 79, No. 182, Oct. 4, 1972, pp. 23–24.

FOREIGN TRADE

Exports of zirconium ore and concentrate, zirconium oxide, and all forms of zirconium metal and alloys, rose in 1972 compared with the 1971 figures.

Zirconium ore and concentrate, exported to 12 countries in 1972, increased from 18,857,871 pounds valued at $801,833 in 1971 to 34,719,653 pounds valued at $940,347. The poundage of zirconium ore and concentrate exported increased 84% over that shipped in 1971, but the value rose only 17%. Both the 1972 quantity and value were alltime highs. The average value of the zirconium ore and concentrate exported in 1972, $54.17 per ton, represented a decline from the 1971 value of $85.04. This decrease is attributed to a large increase in the amount of lower cost zircon sand shipped. Exports in previous years consisted of a larger percentage of the higher cost granular and milled zircon grades. The major recipients of the exported zirconium ore and concentrate were the Netherlands, 38%; United Kingdom, 26%; Mexico, 16%; and Brazil and Canada, 9% each.

Exports of zirconium oxide increased from 1,122,741 pounds valued at $839,025 in 1971 to 1,304,352 pounds valued at $931,867 in 1972. Export quantity and value increased 16% and 11% respectively in 1972. These zirconium oxide shipments were made to 23 countries. The five major recipients in 1972 were West Germany, 26%; Italy, 13%; Canada, 12%; Brazil, 10%; and Mexico, 7%.

Total exports of other classes of zirconium increased nearly 17%, from 1,125,242 pounds in 1971 to 1,314,219 pounds in 1972. The value of this material declined 12% in 1972 to $11,508,858 from the 1971 value of $13,053,378. Of the three categories listed, only zirconium and zirconium alloy foil and leaf increased in both value and quantity in 1972. The zirconium and zirconium alloys, wrought, class increased 18% in the pounds exported but declined approximately 15% in value, and exports of zirconium and zirconium alloys, unwrought and waste and scrap, increased 11% and declined 5% in value.

Imports for consumption of zirconium ores in 1972 declined to 67,537 short tons, an almost 30% decrease from the record high of 96,387 short tons in 1971. The 1972 figure represents the smallest tonnage imported since 1968. Zirconium ore imports from the Republic of South Africa were chiefly baddeleyite (ZrO_2). The remaining zirconium ore imports were believed to be Australian zircon.

The average value of imported zircon at foreign ports increased 32% in 1972 to $46.79 per short ton, compared with $35.36 in 1971. The Republic of South Africa baddeleyite value in 1972 of $387.01 per short ton increased 21% from the 1971 value of $320.32. The tonnage imported declined 30% in 1972.

Imports for consumption of zirconium and hafnium in 1972 increased both in quantity and value in the following categories: Zirconium—wrought, zirconium waste—scrap and unwrought, zirconium compounds—n.e.c., and hafnium, unwrought—waste and scrap. Imports for consumption of zirconium declined in quantity and value in the zirconium alloys—unwrought and zirconium oxide compound classes. No wrought hafnium was imported in 1972.

Table 7.—U.S. exports of zirconium ore and concentrate, by country

Destination	1971		1972	
	Pounds	Value	Pounds	Value
Argentina	193,680	$8,627	44,600	$4,207
Brazil	--	--	3,231,931	84,856
Canada	4,804,760	252,013	3,284,383	181,203
Chile	166,000	6,247	66,922	5,306
Colombia	12,000	1,364	6,000	660
France	22,449	1,273	12,000	1,646
Germany, West	2,250	1,271	--	--
Hong Kong	210,640	17,500	--	--
Ireland	--	--	144,553	8,995
Israel	1,420	891	1,143	617
Italy	5,200	2,185	--	--
Japan	447,507	179,611	79,728	9,675
Mexico	629,867	28,241	5,700,660	208,588
Netherlands	11,160,098	272,274	13,231,733	280,708
United Kingdom	1,202,000	30,336	8,916,000	153,886
Total	18,857,871	801,833	34,719,653	940,347

Table 8.—U.S. exports of zirconium, by class and country

Country	1971		1972	
	Pounds	Value	Pounds	Value
Zirconium and zirconium alloys, wrought:				
Argentina	1,218	$22,892	--	--
Australia	21	576	102	$704
Austria	--	--	61	730
Belgium-Luxembourg	18,761	762,025	144	2,095
Brazil	2,078	5,818	648	6,474
Canada	378,047	3,970,358	571,109	4,602,989
France	781	10,067	879	6,805
Germany, West	163,266	1,623,603	125,448	838,697
India	3,206	110,596	2,266	97,080
Indonesia	33	1,152	--	--
Iran	45	1,550	--	--
Italy	1,533	27,199	2,863	76,950
Jamaica	--	--	1,168	13,895
Japan	115,864	2,697,994	102,677	2,094,776
Netherlands	4,010	22,736	3,179	39,704
Norway	8,248	79,449	19,146	177,740
Peru	17	744	--	--
Portugal	574	6,298	443	5,316
Sweden	14,317	144,926	58,328	564,202
Switzerland	--	--	1,001	4,785
Thailand	365	596	--	--
United Kingdom	46,417	740,952	9,039	196,169
Total	758,801	10,229,531	898,501	8,729,111
Zirconium and zirconium alloys, unwrought and waste and scrap:				
Australia	--	--	708	3,170
Belgium-Luxembourg	250	3,793	1,758	20,035
Brazil	939	4,206	--	--
Canada	2,832	12,685	8,270	68,070
Colombia	424	1,900	--	--
France	2,561	11,474	8,218	64,705
Germany, West	123,922	776,822	78,072	471,506
Guatemala	200	2,270	--	--
India	3,081	18,500	172	2,713
Italy	949	5,475	1,718	27,565
Japan	70,180	694,152	102,725	638,530
Mexico	247	2,938	--	--
Netherlands	349	2,911	969	4,340
Norway	16,643	165,475	1,148	9,329
Portugal	30	1,520	--	--
Sweden	14,491	137,337	75	1,000
Switzerland	--	--	10,349	59,108
Thailand	--	--	179	1,084
United Kingdom	107,635	573,230	169,764	916,761
Yugoslavia	--	--	27	696
Total	344,733	2,414,688	384,152	2,288,612
Zirconium and zirconium alloy foil and leaf:				
Belgium-Luxembourg	2,814	51,207	2,118	35,462
Canada	13,041	272,656	16,096	305,295
Germany, West	909	13,804	--	--
Italy	3,035	53,992	2,192	41,678
Japan	1,809	15,558	--	--
Sweden	--	--	10,878	103,717
United Kingdom	100	1,942	282	4,983
Total	21,708	409,159	31,566	491,135

Table 9.—U.S. exports of zirconium oxide, by country

Country	1971		1972	
	Pounds	Value	Pounds	Value
Argentina	19,319	$14,807	66,962	$54,233
Australia	1,600	1,366	600	900
Austria	22,000	16,324	22,000	16,324
Belgium-Luxembourg	15,765	11,204	14,612	9,790
Bolivia	--	--	500	740
Brazil	41,828	52,202	136,805	96,235
Canada	202,165	132,121	152,986	99,018
Chile	--	--	2,000	1,530
Dominican Republic	549	816	--	--
France	99,971	95,740	49,382	47,357
Germany, West	238,327	167,986	344,319	243,131
Greece	900	1,292	1,500	1,200
Hong Kong	--	--	1,804	1,560
India	--	--	2,060	1,380
Israel	1,200	1,046	3,543	3,033
Italy	123,630	104,824	173,321	146,120
Japan	41,397	29,138	86,639	53,636
Kuwait	500	680	--	--
Mexico	85,620	59,130	92,285	63,581
Netherlands	54,330	33,083	83,960	52,139
Panama	610	620	--	--
Peru	--	--	635	853
Portugal	400	544	--	--
South Africa, Republic of	--	--	500	666
Spain	132,538	88,800	--	--
Sweden	12,073	8,089	53,819	28,226
Switzerland	3,400	2,029	--	--
United Kingdom	23,619	15,824	13,520	9,327
Uruguay	600	816	--	--
Venezuela	400	544	600	888
Total	1,122,741	839,025	1,304,352	931,867

Table 10.—U.S. imports for consumption of zirconium ores, by country

Country [1]	1970		1971		1972	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Australia	86,816	$3,265	93,402	$3,328	66,064	$3,081
Austria	--	--	--	--	49	3
Canada	3,104	98	2,114	49	844	49
Japan	--	--	--	--	168	7
South Africa, Republic of	355	134	871	279	385	149
United Kingdom	4,484	207	--	--	--	--
Venezuela	--	--	--	--	27	2
Total	94,759	3,704	96,387	3,656	67,537	3,291

[1] Except for Australia and the Republic of South Africa, believed to be country of shipment rather than country of origin.

Table 11.—U.S. imports for consumption of zirconium and hafnium in 1972

Country	Pounds	Value
Zirconium, wrought:		
Canada	15,623	$86,561
France	85,991	662,129
Total	101,614	748,690
Zirconium, unwrought and waste and scrap:		
Belgium-Luxembourg	58,145	108,437
Canada	25,447	37,128
Japan	213,404	729,034
Netherlands	11,975	11,283
United Kingdom	1,004	1,056
Total	309,975	886,938
Zirconium alloys, unwrought:		
Canada	509	1,185
France	28	280
Japan	60	1,100
United Kingdom	110	829
Total	707	3,394
Zirconium oxide:		
France	1,323	2,726
Germany, West	1,575	7,026
Switzerland	911	1,038
U.S.S.R	19,842	7,481
United Kingdom	277,236	142,897
Total	300,887	161,168
Zirconium compounds, n.e.c.:		
France	33,951	11,651
Germany, West	58,109	38,407
Japan	20,000	1,980
Netherlands	107	1,068
Switzerland	18	369
United Kingdom	2,189,836	604,392
Total	2,302,021	657,867
Hafnium, unwrought and waste and scrap:		
Belgium-Luxembourg	23	5,468
France	181	6,147
Germany, West	10	1,413
U.S.S.R	68	5,398
Total	282	18,426

WORLD REVIEW

Australia.—E. I. du Pont de Nemours & Co., has entered into a joint mining venture with Allied Minerals N.L. to process mineral sands at Eneabba in Western Australia, about 150 miles north of Perth. The newly formed mining company was named Allied Eneabba Pty. Ltd. A pilot plant was being constructed prior to a full-scale $12 million production plant scheduled for completion by 1975. The production plant is planned to produce 200,000 tons of ilmenite and 50,000 tons of rutile with additional commercial quantities of zircon, monazite, leucoxene, and kyanite.[3]

Westralian Sands Ltd. and British Titan Products Ltd. have agreed to jointly develop and exploit new reserves in Western Australia. The two companies, major ilmenite producers, were planning significant zircon production. The Mining Corp. of Australia Ltd. reported assays in the western section of the Coolyarloo Well area, also in Western Australia. The heavy mineral Coolyarloo Well deposits at a depth of 40 feet assayed 12.2% zircon and over 36% ilmenite, rutile, and leucoxene. Preliminary results from the northern area showed 12% zircon and 76% titaniferous minerals.[4]

Buka Minerals Ltd. announced plans to produce a ceramic-grade zircon from their newly acquired King Island rutile operation. The King Island operation was ac-

[3] E. I. du Pont de Nemours & Co. News. V. 2, No. 1, Jan. 1, 1973, p. 4.
[4] Industrial Minerals. No. 56, May 1972, p. 39.

Table 12.—Zirconium concentrate: Non-Communist world production, by country

(Short tons)

Country	1970	1971	1972 p
Australia	424,902	447,378	397,042
Brazil	4,483	4,956	5,046
India [1]	7,649	9,924	e 12,000
Malagasy Republic	3	3	e 3
Malaysia [2]	948	2,803	2,216
South Africa, Republic of [3]	432	1,092	396
Sri Lanka (formerly Ceylon)	123	153	e 155
Thailand	953	1,682	403
United States	W	W	W
Total	439,493	467,991	417,261

e Estimate. p Preliminary. W Withheld to avoid disclosing individual company confidential data.
1 Output of Indian Rare Earths Ltd. for years beginning April 1 of that stated.
2 Exports.
3 Official Republic of South Africa production figures are not available. Data are the total of zirconium concentrate imports by the United States and Japan and may be only a part of total output.

quired from Naracoopa Rutile Ltd. Zircon production was expected to exceed Naracoopa's old production level, 5,000 tons per year.[5] Lennard Oil Ltd. and Westralian Sands continued their joint evaluation venture of heavy mineral sand prospects north and south of Gingin near Perth. Preliminary results were said to be promising.[6]

A. V. Jennings (Jennings Industries) was proceeding alone on its 12-million-ton-per-year mineral sand project at Eneabba. A planned dry-mining operation using bucket-wheel excavators was to be carried out through a Jennings Industries subsidiary, Research and Exploration Management Pty. Ltd. Capital cost of the Eneabba project was put at $14 million.[7]

Cudgen, R. Z. Ltd., of the Union Corp. group, and its subsidiary, Consolidated Rutile Ltd., announced that they were studying the possibility of integrating their operations. The move was to offset present pressures on the weakening rutile markets.[8] Mineral Deposits Ltd. (MDL) reported increased efficiencies at its Forster processing plant, achieved by modifying the cone concentrators. This increase in efficiency was part of a company plan to more fully utilize its reserves, both low and high grade. In addition, MDL reportedly carried out several extensive and successful zircon and rutile exploration projects. Stated reserves of zircon and rutile were put at 1.2 million tons each.[9]

Brazil.—The Minegral-Companhia Brasileira de Minerações, Indústria e Commércio was recovering a high-grade zircon concentrate from its monazite beach sand processing operation.

Canada.—Eldorado Nuclear Ltd. suspended zirconium production at its Port Hope, Ontario, plant. The plant produced zirconium ingot metal and alloy for pressure tubes and fuel-cladding tubes for domestic consumption. Eldorado's unique zirconium process bypassed the conventional sponge metal step and produced ingot directly from zircon.[10]

Egypt, Arab Republic of.—Strips of natural black sand concentrates, approximately 1 kilometer wide and near 5 meters thick, containing between 5% and 7% zircon, were reported on the seashores from Al-Arish up to Marsa Matrouh. These natural black sand concentrates, carried by the Nile River to the Mediterranean Sea, were claimed to be among the world's largest known reserves.[11]

Germany, West.—Mannesmannröhren-Werke announced final plans for the completion of its plant for producing zirconium alloy tubing for nuclear reactors.[12]

Italy.—A new company partnership, Refradige S.p.A., was formed to take over production of fusion-cast refractories in Montedison's plant at San Michele all'Adige. The other partner in the new

5 Industrial Minerals. No. 60, September 1972, p. 33.
6 Page 49 of work cited in footnote 5.
7 Industrial Minerals. No. 54, March 1972, p. 18.
Mining Magazine. Australasia. V. 127, No. 3, September 1972, p. 202.
8 Industrial Minerals. No. 62, November 1972, p. 42.
9 Industrial Minerals. No. 57, June 1972, p. 53.
10 Brown, D. C. Zirconium and Hafnium. No. 53, Canadian Minerals Yearbook, 1971.
11 Yousef, A. A., T. R. Boulos, and M. Y. Saada. Egypt's Mineral Resources. Min. Mag., v. 127, No. 3, September 1972, pp. 265, 267, 269.
12 Gadsen, P. Zirconium and Hafnium. Min. J., (London), June 1972, p. 94.

company was the French Saint Gobain group. The new company's refractories, chiefly alumina-zirconia-silica types, were intended for the glass industry.[13]

Japan.—Mitsui and Co., Ltd., and Teledyne's Wah Chang Albany were considering a joint company to produce zirconium metal for the Japanese market. Japanese demand for nuclear-reactor-grade zirconium tubing was expected to be 1,000 tons per year by 1975.[14]

New Zealand.—Large quantities of mineral sands were reportedly proven out by drilling along the western beaches of North and South Islands. An impact study was underway to determine the effect of this new discovery on the existing mineral sands industry and whether or not exploitation of these deposits would be to New Zealand's best interests.

Sierra Leone.—A new company, Sierra Rutile Ltd., has been formed to take over the leases of PPG Industries, Inc., and British Titan Products, Ltd., Sherbro Minerals, Ltd. Sierra Rutile Ltd. is owned by Armco Steel Corp. and Nord Resources Corp., U.S. companies, with the latter managing the mining operation. The new company was planning to produce 100,000 tons of rutile per year. The planned zircon production, although reportedly significant, was unannounced.[15]

South Africa, Republic of.—The Phosphate Development Corp. Ltd. (FOSKOR) was undergoing another expansion to fulfill the increasing demand for its unique baddeleyite concentrate. Palabora Mining Co. Ltd., mining a contiguous deposit in the Palabora igneous complex, was exploring the possibility of marketing its stockpiled baddeleyite. The baddeleyite is a coproduct from a copper and iron operation. Palabora Mining was also conducting research to further upgrade the slightly radioactive fine-grained baddeleyite into more salable products.[16]

Victor Base Minerals Corp. Ltd. and Cape Morgan Titanium Mines Corp. Ltd. were planning to begin ilmenite, rutile, and zircon production in 1973. Total zircon production from these two operations was estimated to be approximately 10,000 tons per year.[17]

General Mining and Finance Corp. Ltd., in a joint project with United States Steel Corp., reported promising assays of heavy mineral sands, containing both titanium mineralization and zircon, along the Zululand Coast.[18]

Sri Lanka (formerly Ceylon).—Ceylon Mineral Sands Corp. (CMSC), a state-owned corporation, was expanding its mineral sands operation at Pulmoddai Beach on the northeast coast. CMSC was planning a 9,000-ton-per-year increase in zircon production. CMSC put reserves of mineral sands at 3.26 million tons, averaging 80% ilmenite and rutile. The entire mineral sand production was intended for export, with Japan as the principal market.[19]

TECHNOLOGY

A Bureau of Mines study on the availability of heavy minerals as a byproduct from sand-washing plants in the Southeastern Coastal Plain States was published. Recovery of the heavy mineral fraction, chiefly rutile, ilmenite, kyanite, zircon, and monazite, citing rutile as the example, was found to be uneconomical at current market prices.[20] Experimental investigation of a laboratory-scale open-cycle vortex magnetohydrodynamic (MHD) generator at the Bureau's Pittsburgh Energy Research Center indicated that this configuration offered many advantages over straight-channel generators that require separate combustors. Compactness, lower capital cost, and high energy release were obtained by combining the combustor and generator into one unit in the vortex generators.[21] The ultra-high-temperature MHD systems use stabilized zirconia electrodes and insulator materials. In further MHD research the Of-

[13] Work cited in footnote 4.
[14] Work cited in footnote 12.
[15] Pages 25, 26 of work cited in footnote 4.
[16] Nel, V. Palabora's New Heavy Minerals Plant Adds Uranium Concentrate to the Recovery List. Eng. and Min. J., v. 173, No. 11, November 1972, pp. 186–187.
Page 74 of work cited in footnote 12.
[17] Gadsen, P. Titanium Annual Review. Min. J. (London), June 1972, p. 63.
[18] Page 51 of work cited in footnote 9.
[19] Industrial Minerals. No. 52, January 1972, pp. 31, 32. Industrial Minerals. No. 61, October 1972, p. 48.
[20] Cochran, W., and R. L. Smith. Availability of Rutile as a Byproduct From Sand-Washing Plants in the Southeastern United States. BuMines IC 8540, 1972, 22 pp.
[21] Conroy, G. J., R. C. Kurtzrock, R. B. Snedden, J. J. Demeter, D. Bienstock, and W. F. Hughes. Experimental Investigations of An Open-Cycle, Vortex MHD Generator. BuMines RI 7699, 1972, 28 pp.

fice of Coal Research has contracted with the Massachusetts Institute of Technology (MIT) to assist in evaluating progress and to provide guidance in the overall government MHD-development plan (now comprising nine other contractors). MIT was advising on special investigations in the areas of high-temperature electrode materials, thermal-shock-resistant materials, and coal particle combustion.

Bureau of Mines research efforts were also directed towards determining the chlorination kinetics of zirconium dioxide and the technique of electrowinning zirconium from zirconium tetrachloride in an electrolytic cell. The former revealed that introducing carbon to the chlorinating reaction, instead of the conventional direct zirconium dioxide chlorination, resulted in reaction temperatures of approximately 800° C, or more 200° C lower than the previously used temperatures. Substitution of gaseous carbon monoxide as the reductant, in lieu of carbon, resulted in even greater efficiency.[22] The electrowinning research succeeded in plating high-purity zirconium dendrites from zirconium tetrachloride at 800° C using an electrolyte containing NaCl-NaF. The high-purity electrowon zirconium produced surpassed the American Society for Testing and Materials specifications for commercially acceptable sponge.[23] The geology, mineralogy, and economic uses of Florida heavy minerals, with emphasis on the du Pont Trail Ridge deposits at Starke and Lawtey, were related to present and future mining operations.[24]

Sodium sulfide, as a regulator, was discovered to be effective in separating monazite from zircon, by soap flotation, from the nonmagnetic fraction of selected Egyptian Mediterranean beach sand deposits.[25] The effect and the projected expanded role of cone concentrators in high-capacity mineral sand processing operations were analyzed critically.[26]

The purification of Republic of South Africa baddeleyite ores by an initial chlorinating step followed by a water leach was reported. The method involves chlorinating the finely divided ore with either carbon tetrachloride or perchloroeythlene, between 400° and 700° C, in the presence of an inert carrier gas to remove the volatile contaminating metal chlorides. The nonvolatile metal chlorides are removed by water leaching.[27] The extraction of zircon from Canadian bituminous sands by a multiple-stage flotation technique was announced. The ore slurry is first introduced into hot water, which causes the zircon and bitumen fraction to froth float. The zircon-rich froth is separated and subsequently leached with sodium hydroxide. After leaching, the zircon concentrate is removed as the zircon-rich underflow after aerating to float the solid impurities away.[28]

A thorough discussion of Australian mineral sands resources, reserves, and supply-demand position was published.[29] Recent developments including characteristics, relative economics, and applications of the two continuous-operating dredges, the hydraulic cutterhead and bucket-line ladder, were presented.[30] The dry mining and processing operations of a large Australian mineral sands producer were detailed.[31]

The preparation and chemical behavior of the hydrochlorides of zirconium oxide and its relationship to their molecular structures were discussed in detail. The zirconium hydrochlorides are intermediate compounds in the preparation of many zirconium salts.[32] Zirconium carbide-carbon composite, a promising oxidation-resistant material, was vapor-deposited directly by

[22] Landsberg, A., C. L. Hoaston, and F. E. Block. The Chlorination Kinetics of Zirconium Dioxide in the Presence of Carbon and Carbon Monoxide. Met. Trans., v. 3, No. 2, February 1972, pp. 517–523.

[23] Martinez, G. M., and D. E. Couch. Electrowinning of Zirconium From Zirconium Tetrachloride. Met. Trans., v. 3, No. 2, February 1972, pp. 571–574.

[24] Garnar, T. E., Jr. Economic Geology of Florida Heavy Minerals. Proc. 7th Forum on Geology of the Ind. Mines, Tampa, Fla., Apr. 28–30, 1971. Fla. Dept. Nat. Res., Div. Int. Res., Bur. of Geol., Tallahassee, Fla., Spec. Pub. 17 (ed. by H. S. Puri), June 1972, pp. 17–21.

[25] Abeidu, A. M. The Separation of Monazite From Zircon by Flotation. J. Less-Common Metals, v. 29, No. 2, October 1972, pp. 113–119.

[26] Ferree, T. J. An Expanded Role in Minerals Processing Seen for Reichert Cone. Min. Eng., v. 25, No. 3, March 1973, pp. 29–31.

[27] Brugger, W. Process for Purifying Zirconium Ores. British Pat. 1,285,129, Aug. 9, 1972.

[28] Penzes, S. Treatment of Bituminous Sands for Recovery of Heavy Metals Therefrom. U.S. Pat. 3,656,938, Apr. 18, 1972.

[29] Ward, J. Australian Resources of Mineral Sands. Australian Mines Ind., Quart. Rev., v. 25, No. 1, September 1972, pp. 12–22.

[30] Barker, G. and C. McKay. Some New Concepts in Dredge Design. Min. Mag., v. 127, No. 1, July 1972, pp. 25, 29, 31.

[31] Mining Magazine. Australia Steps Up Mineral Sand Exports. V. 126, No. 4, April 1972, pp. 273, 275.

[32] Blumenthal, W. B. Hydrochlorides of Zirconium Oxide. J. Less-Common Metals, v. 30, No. 1, January 1973, pp. 39–46.

reacting zirconium sponge with methyl iodide[33] and/or methylene dichloride or chlorine.[34]

The preparation and thermal decomposition characteristics of zirconium- and hafnium-bearing polyester fibers for use as heat- and weather-resistant additives, as adhesives and adhesion promoters, as waterproofing and flameproofing agents for paper and textiles, and as fuel oil additives were reported during the year.[35]

Partially stabilized zirconia ceramics in the system CaO-ZrO_2 were found to be superior to conventionally prepared fully stabilized zirconia in thermal-shock properties.[36] Thermal expansion studies in the system Y_2O_3-HfO_2, from ambient temperature to 2,000° C, indicated that a stable high-temperature ceramic material can be produced by adding from 8 to 50 mole-percent Y_2O_3 to HfO_2.[37]

The AMAX Zr-Hf Newsletter[38] listed nearly 2,000 articles relating to zirconium and hafnium technology in 1972. Many of these articles were devoted to the use of zirconium and hafnium as metal alone, in alloys, and as alloying elements, not only in nuclear applications, but also in refractory and oxidation- and corrosion-resistance technology.

A comprehensive thesis on zirconium alloys, with particular emphasis on corrosion, deformation, tubing properties, and alloy development, was published. The papers listed in this thesis were presented at the International Symposium on Zirconium Alloys in Montreal, Canada, August 31, and September 1, 1971.[39] Methods for producing columbium alloy composites reinforced with TZM (titanium-zirconium-molybdenum) wire, by explosive welding techniques, were successfully developed.[40]

Materials Research Corp. announced two new techniques for producing high-purity zirconium wire, 0.002 inch thick. One technique is called the electron beam float zone refinement method, and it produces the higher purity wire in the 99.99% to 99.999% zirconium range. The other technique, electron beam melting, produces a wire of lower purity.[41]

---

[33] Ikawa, K. Vapor Deposition of Zirconium Carbide-Carbon Composites by the Iodide Process. J. Less-Common Metals, v. 27, No. 3, June 1972, pp. 325-332.

[34] Ikawa, K. Vapor Deposition of Zirconium Carbide-Carbon Composites by the Chloride Process. J. Less-Common Metals, v. 29, No. 3, November 1972, pp. 233-239.

[35] Carraher, C. E., Jr. Fiber Forming and Thermal Properties of Polyesters of Group IV Metals. Chem. Technol., v. 2, No. 12, December 1972, pp. 741-744.

[36] Garvie, R. C., and P. S. Nicholson. Structure and Thermomechanical Properties of Partially Stabilized Zirconia in the CaO-ZrO_2 System. J. Am. Ceram. Soc., v. 55, No. 3, March 1972, pp. 152-157.

[37] Stacy, D. W., and D. R. Wilder. Thermal Expansion in the System Y_2O_3-HfO_2. J. Am. Ceram. Soc., v. 56, No. 4, April 1973, p. 224.

[38] Published by AMAX Specialty Metals Division, P.O. Box 32, Akron, N.Y. 14001.

[39] Canadian Metallurgical Quarterly. Zirconium (papers presented at the International Symposium on Zirconium Alloys, Montreal, Canada, Aug. 31-Sept. 1, 1971). V. 11, No. 1, January-March 1972, 283 pp.

[40] Denver Research Institute. Development of Explosively Bonded TZM Wire Reinforced Columbium Sheet Composites. NASA-CR-123,937, DRI-2608, September 1972, 54 pp.

[41] Material Information and Data Service. Materials Engineering. V. 75, No. 2, February 1972, p. 66.

Minor Metals

By Staff, Division of Nonferrous Metals

CONTENTS

ARSENIC [1]

Domestic Production.—Arsenic trioxide was produced in the United States as a byproduct of base-metal ores, primarily copper ore, at the Tacoma, Wash., plant of the American Smelting and Refining Company. Production figures cannot be published. Production in 1972, however, rose substantially over that in 1971 which had been curtailed by the strike at copper facilities. Shipments were less than production and yearend stocks continued the upward trend begun in 1968.

Consumption and Uses.—Apparent consumption of arsenic, essentially all as white arsenic (As_2O_3), decreased slightly from that in 1971. Calcium and lead arsenate chemicals were the major end products. Minor quantities of arsenic were used in sodium arsenate and other chemical compounds.

Production of calcium arsenate has trended downward since 1968 when nearly 1,700 tons was produced. Less than 600 tons was produced in 1969 and in 1970, and only 470 tons was produced in 1971. Lead arsenate, on the other hand, rose to nearly 3,100 tons in 1971 from 2,100 tons in 1970.

Arsenic is primarily used for its toxic qualities in the agricultural industry for insecticides, selective plant killers, defoliants, and for parasitic control in chicken feed; arsenic compounds continued to be used as wood preservatives. Consumption of Wolman Salts, the principal arsenic preservative, totaled 1,085 tons in 1971 compared with 806 tons in 1970.

About 3% of the arsenic consumed is used as metal for alloying with lead and copper. Small quantities of high-purity arsenic are used in the electronics industry.

Prices.—The price of refined white arsenic, 99.5%, at New York docks, in barrels, small lots, has been unchanged at 6-1/4 to 6-3/4 cents per pound since July 6, 1968. Refined white arsenic in bulk carload lots at Laredo, Tex., was $120 per ton, and crude white arsenic was quoted at $94 per ton at Tacoma, Wash. Lead arsenate in 50-pound bags was quoted at 26 to 29 cents per pound throughout 1972.

Arsenic metal was quoted in London at £600 nominal per long ton (64.3 cents per pound) until mid-May when it rose to £650 (69.5 cents). In July the price rose to £690 per metric ton (75.1 cents per pound) where it remained through yearend.

Foreign Trade.—No exports of arsenic metal or white arsenic have been reported since 1945.

Imports of white arsenic declined 21% in 1972 to 13,600 tons, the lowest level since 1960. Sweden, the principal supplier of white arsenic, furnished 60%, followed by Mexico with 26%, and France with 11%.

---

[1] Prepared by Gertrude N. Greenspoon, mineral specialist.

Receipts of arsenic metal were 665 tons, 24% more than in 1971. Sweden supplied 659 tons, Canada 5 tons, and Japan 1 ton. Small quantities were received from Belgium-Luxembourg, West Germany, the Netherlands, and the United Kingdom.

Tariff.—Under the General Agreement on Tariffs and Trade (GATT), the duty on arsenic metal was reduced from 1.5 to 1.2 cents per pound, effective January 1, 1972. Arsenic oxide (white arsenic) enters duty free.

Table 1.—U.S. imports for consumption of white arsenic, (As_2O_3) content, by country

Country	1970		1971		1972	
	Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
Belgium-Luxembourg	--	--	25	$9	1	$7
France	2,650	$274	1,425	180	1,556	184
Germany, West	--	--	(1)	(1)	11	4
Mexico	7,750	867	8,316	980	3,552	462
Peru	110	65	68	27	24	27
South Africa, Republic of	111	13	196	23	285	44
Sweden	8,142	870	r 7,276	968	8,184	1,228
Total	18,763	2,089	r 17,306	2,187	13,613	1,956

r Revised.
1 Less than ½ unit.

Table 2.—U.S. imports for consumption of arsenicals, by class
(Thousand pounds and thousand dollars)

Class	1970		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value
White arsenic (As_2O_3)	37,525	2,089	r 34,612	2,187	27,226	1,956
Metallic arsenic	912	1,876	1,072	1,260	1,331	1,790
Sulfide	17	5	--	--	2	(1)
Sodium arsenate	186	23	248	35	479	69
Lead arsenate	--	--	4	1	--	--
Arsenic compounds, n.e.c.	42	50	1	26	(1)	19

r Revised.
1 Less than ½ unit.

World Review.—*Brazil.*—All white arsenic produced in Brazil is recovered as a byproduct from the treatment of gold ore produced at the Morro Velho mine near Belo Horizonte. The mine is operated by Mineração Morro Velho, S.A. Peak output was attained in 1951 when 1,500 tons was produced. Thereafter, production trended downward to 181 tons in 1972.

France.—Two processing plants, one each in the Aude and Bouches du Rhône Departments, account for all white arsenic produced in France. About half of the output is derived from arsenical pyrite produced in Aude and the remainder comes from the treatment of imported ores.

Sweden.—The Boliden Co. will build a new plant for the production of arsenic metal.[2] The plant located at the company Rönnskär works will have an initial capacity of 1,500 tons annually and is estimated to cost $2 million. A new process developed by Boliden, which will be utilized, is said to be virtually continuous, will provide a good working environment, and will create no pollution. All production units will be equipped with closed ventilation systems. Ventilation air and process gases will be treated in wet scrubbers and the scrub water will be highly purified before disposal.

Technology.—In a study[3] conducted on methods for removing arsenic from gold extraction plant effluents, the chemical precipitation process was considered to be effective and the most attractive from an economic standpoint. Two other methods—ion exchange resins and activated charcoal adsorption, and reverse osmosis—were alternative choices also investigated.

[2] Mining Journal (London). New Process for Arsenic Plant. V. 280, No. 7171, Jan. 26, 1973, p. 73.

[3] Rosehart, R., and J. Lee. Effective Methods of Arsenic Removal From Gold Mine Wastes. Canadian Min. J., v. 93, No. 6, June 1972, pp. 53–57.

Table 3.—White arsenic (arsenic trioxide) [1]: World production, by country

(Short tons)

Country [2]	1970	1971	1972 p
Brazil	328	163	181
Canada	71	50	30
France	11,236	e 11,000	e 11,000
Germany, West	408	40	e 550
Japan	974	1,054	471
Mexico	10,075	12,658	6,523
Peru	851	723	1,123
Portugal	209	205	e 210
South-West Africa, Territory of [3]	4,478	4,080	e 4,400
Spain	19	--	--
Sweden	18,078	e 17,600	e 17,600
U.S.S.R. e	7,880	7,880	7,940
United States	W	W	W
Total	r 54,607	55,453	50,028

e Estimate. p Preliminary. r Revised. W Withheld to avoid disclosing individual company confidential data.

1 Including calculated trioxide equivalent for output reported as elemental arsenic and arsenic compounds other than trioxide.

2 In addition to the countries listed Argentina, 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, and if so at what levels.

3 Output of Tsumeb Corp. Ltd. for year ending June 30 of that stated; data given are white arsenic equivalent of reported black arsenic oxide production.

Background data for the study disclosed that the arsenic dissolved in the final plant effluent discharged to the lake constituted only 0.3% of the arsenic contained in the mill feed. Distribution of the remainder of the mine arsenic balance was 14.8% in solids discharged to the lake, 2.6% in mine backfill, 1.8% in roaster flue dust, and 80.5% (by difference) in roaster stack losses.

CESIUM AND RUBIDIUM [4]

Domestic Production.—No cesium or rubidium ores were produced in the United States in 1972. Imported pollucite and *ALKARB*, a residue from past lithium compound production, were the raw material sources for all domestic production of cesium and rubidium products.

The total production of the chemical compounds of cesium declined in 1972 while the production of rubidium compounds increased. Compounds were produced by Cooper Chemical Co., Long Valley, N.J.; Kawecki Berylco Industries, Inc. (KBI), Revere, Pa.; Kerr-McGee Corp., Trona, Calif.; and Rocky Mountain Research, Inc., Golden Colo. No rubidium metal and only a few pounds of cesium metal were produced during the year. KBI and MSA Research Corp., Evans City, Pa., shipped both metals from inventories.

Consumption and Uses.—Statistics on the consumption and uses of cesium and rubidium metal and compounds were not available. The largest use was probably in research and development of new power generating systems, the biological sciences, and other technical fields. Commercial applications for cesium and rubidium included their use in pharmaceuticals, scintillation counters, photomultiplier tubes, photoelectric cells, ultracentrifuges, and ionic propellant engines for space-flight applications. Cesium and rubidium and their compounds can be substituted for each other in some uses.

The development of commercial-scale magnetohydrodynamic (MHD) electric power generators and thermionic converters appeared to offer the greatest potential for large usage of cesium and rubidium. Research on MHD received increased funding both privately and through the Office of Coal Research, U.S. Department of the Interior. If successfully developed, MHD was expected to provide cheaper electricity and major increases in power generating efficiency. Investigations have indicated that a mixed potassium-cesium seeding is

4 Prepared by Horace F. Kurtz, industry economist.

Table 4.—Prices of selected cesium and rubidium compounds

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.

desirable for open-cycle MHD coal-burning power plants.[5]

Prices.—American Metal Market quoted a nominal price for pollucite (about 20% Cs) over 10 tons, delivered entry point, at $300 per short ton. Metal Bulletin quoted a nominal price for pollucite concentrates, minimum 24% Cs_2O, f.o.b. source, at $12.40 (using 1£ = $2.60) per metric ton unit (22.046 pounds) of Cs_2O. The American Metal Market quotation on cesium metal 99+% was unchanged at $100 to $375 per pound. The quotation on rubidium metal, 99.5+%, was also unchanged at $300 per pound.

Foreign Trade.—Pollucite was imported from Canada during 1972, but data on quantities and values of imports of cesium and rubidium raw materials were not published. Imports of cesium compounds increased to over 12,000 pounds nearly three times the quantity in 1971. Rubidium metal was not imported during 1972. No other data were available on imports and exports of cesium and rubidium products.

Table 5.—U.S. imports for consumption of cesium compounds, by country

Country	Cesium chloride		Cesium compounds, n.s.p.f.	
	Pounds	Value	Pounds	Value
Germany, West	1,661	$56,934	8,358	$252,328
Netherlands	--	--	1,974	20,078
United Kingdom	--	--	55	1,351
Total	1,661	56,934	10,387	273,757

World Review.—In 1971, Tantalum Mining Corp. of Canada, Ltd., produced about 400 tons of pollucite at its mine at Bernic Lake, Manitoba. The company did not mine pollucite in 1972, but shipments were made from stocks.

GERMANIUM [6]

The short supply situation reversed itself in mid-1970 when semiconductor demand dropped by an estimated 50% resulting in excessive consumer stocks and an oversupply of germanium for a brief period of 1 to 1½ years. Demand has increased since the 1970 slump with a slow and steady growth in both the semiconductor and optical industry. Estimated production of germanium from primary and secondary sources for 1972 was the same when compared to 1971.

Legislation and Government Programs.—Information was received on August 21, 1972, that germanium point contact diodes from Japan were being sold at less than fair value within the meaning of the Antidumping Act, 1921, as amended. This information was the subject of an "Antidumping Proceeding Notice" which was published in the Federal Register, September 23, 1972, page 20046. The notice indicated that there was evidence on record concerning injury to or prevention of establishment of an industry in the United States.

Domestic Production.—Production of primary germanium from domestic raw material sources was estimated at 27,000

[5] Bergman, P. D., and D. Bienstock. Economics of Mixed Potassium-Cesium Seeding of an MHD Combustion Plasma. BuMines RI 7717, 1972, 12 pp.

[6] Prepared by Herbert R. Babitzke, physical scientist.

pounds in 1972, with an additional estimated 10,000 pounds recovered from germanium-containing zinc concentrates imported from other countries. Most of the primary germanium was obtained from treating smelter residues resulting from the processing of roasted zinc concentrates. No mines are operated solely for recovery of germanium. This metal is a minor byproduct of ores mined for zinc with the supply of germanium being a function of the zinc production rate. Although at present no new residues are derived from treating ores of the Kansas-Missouri-Oklahoma region or from Kentucky and Illinois, a significant supply of residues has been stockpiled. Primary production was supplemented with recycled waste or new scrap. Waste recycle returns from 65% to 80% of the metal as scrap from cutting shapes used in the manufacture of semiconductors. Eagle-Picher Industries, Inc. of Miami, Okla., was the only producer of primary germanium from domestic sources. The above company and others listed below produced germanium from secondary sources and imports: GTE Sylvania, Towanda, Pa.; Kawecki Berylco Industries, Inc., Revere, Pa.; and Atomergic Chemetals Co., Long Island, N.Y.

Consumption and Uses.—The principal form in which germanium is used for semiconductors is as high-purity single crystal metal while for optical applications the material must be of high purity but may be polycrystalline. Semiconductor devices account for a large portion of the domestic demand. Electronic components account for 55% of the current use of germanium, and the remaining 45% is consumed in the manufacture of specialized optical glass, infrared equipment, and other minor applications. Germanium and silicon transistors, diodes, and rectifiers have replaced vacuum or electron tubes in many applications where cost-performance ratios have been competitive and where miniaturization is necessary in solid state devices. A market for germanium will continue to exist in those semiconductor applications where it is more reliable than silicon, specifically in some high-frequency and high-power requirements.

Germanium has numerous miscellaneous applications including nuclear radiation detectors, in solder and brazing alloys, as an alloying constituent to improve the mechanical properties of copper, aluminum, and magnesium alloys, in thermistors, photoconductors, and superconductors. Germanium has a high refractive index and is transparent to infrared light. To take advantage of this unique property, germanium windows, prisms, or lenses are employed in various optical systems.

Research is continuing in a number of areas which employ germanium. A large part of the research was to establish more of the physical constants of germanium and various germanium alloys and compounds.

A significant contribution was made to the petroleum refining industry when a new series of petroleum catalysts were developed. In the bimetallic cat-cracking catalysts platinum is one of the components and the second metals considered were gold, gallium, germanium, indium, and iridium.[7] A patent was issued to Universal Oil Products Co., Des Plaines, Ill., concerning a novel catalytic composite.[8] The catalyst comprised a combination of a platinum-group component, a germanium component, and a halogen component with a porous carrier material to result in a composite containing 0.01 to 2.0 weight-percent platinum, 0.01 to 5.0 weight-percent germanium, and 0.5 to 3.5 weight-percent halogen. The principal use of the composite was in the conversion of hydrocarbons, particularly in the reforming of a gasoline fraction. This catalyst had exceptional activity, selectivity, and resistance to deactivation when employed in a hydrocarbon conversion process that requires a catalyst having both a hydrogenation-dehydrogenation function and an acid function.

Highly refined germanium is one of the keys to making an X-ray spectrometer used for measuring the lead content of ordinary steels. The lead content is a gage of machinability. The spectrometer, the first of its kind in industry was placed in operation in a steel plant in September 1972. The instrument operates through X-ray fluorescence analysis, using cobalt as the radioactive source. When the steel sample is exposed to the high-energy X-rays from

[7] Burke, Donald P. A Comprehensive Look at a $168-million/year Business Headed for Spectacular Growth. Part 1: Petroleum Catalysts. Chem. Week, v. 111, No. 18, Nov. 1, 1972, pp. 23–33.

[8] Hayes, John C. Hydrocarbon Conversion Process and Platinum-Germanium Catalytic Composite for Use Therein. U.S. Pat. 3,578,584, May 11, 1971.

the radioisotope, the lead particles become fluoresced or energized. The fluoresced lead X-rays are then counted by the unit's germanium transducer, and digital electronics provides the necessary energy analysis.

Prices.—The price of domestic zone-refined (intrinsic) germanium was $293 per kilogram and germanium dioxide was $167.50 per kilogram. These prices have been in effect since June 8, 1970. At the beginning of the year, imported germanium and germanium dioxide was $207 and $108.50 per kilogram, respectively, effective since January 1, 1971, but on April 1, 1972, the prices of imported germanium and germanium dioxide were increased to $229 and $120 per kilogram, where they remained through the end of the year.

Foreign Trade.—U.S. imports of germanium metal (unwrought, and waste and scrap) was 5,506 pounds valued at $724,331, a decrease from the previous year of 17% in quantity and 30% in value. The U.S.S.R. supplied 54% of the germanium imports. Belgium-Luxembourg supplied only 10% of the germanium but this represented 63% of the total value.

World Review.—World production of primary germanium was estimated at 160,000 pounds for 1972 which was 7% more than in 1971. Production in Japan was 49,395 pounds of germanium and 27,192 pounds of germanium dioxide. Japan also imported 593 pounds of germanium metal and 44,536 pounds of germanium dioxide. All African production of germanium was from the Shaba and Kivu Provinces of Zaire. In 1971, 117,000 pounds of germanium was produced by La Générale des Carrierès et des Mines du Zaire (Gécamines), a Zairian government company under contract with the Société Gènérale des Minerais of Belgium. Refining was done in Belgium.

Table 6.—U.S. imports for consumption of germanium, by country

Country	Quantity	Value
	Unwrought, and waste and scrap	
Belgium-Luxembourg	544	$455,401
Czechoslovakia	932	46,950
Denmark	220	15,705
Germany, West	336	25,292
Netherlands	254	13,196
Switzerland	165	10,819
U.S.S.R.	2,966	150,425
United Kingdom	89	6,543
Total	5,506	724,331
	Wrought	
Belgium-Luxembourg	13	3,134
Denmark	102	10,000
Switzerland	289	20,442
Total	404	33,576

INDIUM [9]

Domestic Production.—The American Smelting and Refining Company was the only domestic producer of indium during the year. Refining plants were situated in Denver, Colo., and Perth Amboy, N.J. Indium was recovered from flue dusts and residues in which indium source materials were concentrated during the processing of zinc ores and concentrates.

Uses.—The chief use of indium was in various applications in the manufacture of electronic devices. It was used as a component of solder for connecting lead wires to germanium in transistors and as a property-modifying agent in intermetallic germanium semiconductors. Indium compounds (arsenides, antimonides, and phosphides) were used in various electronic applications; indium halides were used as a color correctant in mercury vapor lamps. Indium-containing alloys were used in glass-sealing, and in dentistry.

Stocks.—Despite increased imports, stocks were estimated to have decreased.

Prices.—Producer prices of indium during the year were unchanged at $2.50 per troy ounce for sticks in lots of less than 100 ounces; ingots of 100 ounces brought $2.05 per ounce and lots of 10,000 ounces were priced at $1.75 per ounce. Probably very little metal moved at $1.75 as the dealer's price was in the range of $1.20 to $1.40 per ounce in ingot lots. Metals Week started quoting ingots at $1.75 effective December 14, 1972, and ceased quoting sticks.

Foreign Trade.—Imports of indium rose 62% over 1971 imports to 628,887 ounces. The lower world price of the material accounted for the growth of imports, because foreign metal could be traded by dealers for more than $1.00 per ounce less than

[9] Prepared by Burton E. Ashley, physical scientist.

the domestic producer price. The chief sources of imports were: Canada, 33%; U.S.S.R., 27%; Peru, 15%; United Kingdom, 14%; and others, 11%.

In accordance with decisions made under the General Agreement on Tariffs and Trade, the import duty on unwrought, waste and scrap metal was 5% ad valorem for 1972; however, such duties were temporarily suspended until June 30, 1973, under Public Law 92–44 which was effective June 30, 1971. Wrought metal was dutiable at a rate of 9% ad valorem and indium compounds at 5% ad valorem. The statutory rate on unwrought, waste and scrap metal, and on compounds, remained at 25% ad valorem from Communist-bloc countries; the duty on wrought metal was 45% from Communist-bloc countries, with Yugoslavia excepted in both cases.

Table 7.—U.S. imports for consumption of indium, by country

Country	Quantity (troy ounces)	Value
	Unwrought, waste and scrap	
Canada	209,928	$216,731
Germany, West	44,440	51,599
Japan	18,452	92,606
Netherlands	5,449	10,165
Peru	94,104	144,461
U.S.S.R	170,242	281,850
United Kingdom	85,185	113,473
Total	627,800	910,885
	Wrought	
Netherlands	1,087	1,373

RADIUM [10]

During 1972, radium was used primarily in therapeutic treatment of cancer. There were fewer industrial applications as substitution by cheaper and less hazardous radioisotopes continued.

Legislation and Government Program.—During 1972, there were no specific Federal programs related to radium only. Radium was not held in Governmental stockpiles. Imports of radium and its compounds were free of tariff.

Domestic Production.—Radium has not been produced in the United States for many years. The small domestic requirements were met by imports or withdrawal from dealers' stocks. The Belgian company, Union Minière S.A., remained the principal source of imported radium during 1972. Radium Chemical Co., Inc., New York, was the main radium dealer in the United States during 1972.

Uses.—Radium, in small quantities expressed in milligrams, was used in treatment of cancer and in luminous compounds, static eliminators, and neutron sources. Based on manufacturers' sales data, about 1,300 to 1,600 curies [11] of radium have been sold in the United States to date. Approximately 330 to 360 curies of radium, contained in 50,000 to 60,000 sources, were used in medical applications. Nonmedical uses accounted for 250 curies, and the rest was involved in luminous compounds and other uses.[12]

Up to 40 curies are added annually to the totals of radium in use in the United States. The after-effects of gamma radiation in medical applications and the price of radium have lead to substitution by other radioisotopes. This trend was also apparent in other uses of radium.

Prices.—Radium prices, per milligram, were quoted by Radium Chemical Co., as follows: Less than 100 milligrams, $24; 200 to 499 milligrams, $20; 500 milligrams to 4.99 grams, $18; over 5 grams, $17.

World Review.—Information on radium in world markets is not readily available, mainly because of the small quantities involved in production and trade. Small amounts of radium and its compounds are produced in Belgium, Canada, the United Kingdom, and the U.S.S.R. Trade in radium was not published as such; in most cases, radium is included with other items in trade statistics.

Technology.—The Federal Bureau of Mines continued a study to develop techniques for recovering radium from uranium ores, tailings, and processing solu-

[10] Prepared by Roman V. Sondermayer, physical scientist.

[11] One curie is equivalent to radioactivity of 1 gram of pure radium, or 3.7 × 10 disintegrations per second.

[12] Data on uses are estimates based on partial sales reports.

tions to eliminate this radioactive contaminant. Leaching of uranium ores with hydrochloric acid resulted in extraction of 20% to 90% of contained radium. During 1972, samples of domestic uranium ores and uranium mill tailings were examined. Results confirmed fair recovery of radium. In case of increased future demand, this method could become a new source of radium.

SCANDIUM [13]

Production of scandium metal, measured in grams, increased slightly compared with that of 1971. Scandium was used mostly in reasearch and in production of high-intensity lamps. The main potential raw material source for scandium was waste products from uranium mills although none was recovered in 1972. The bulk of domestic demand apparently was met by imports. Trade in scandium was not reported as such, but was included with other items in trade statistics.

Domestic Production.—Research Chemicals, a division of Nucor Corp., Phoenix, Ariz., was the only domestic producer of scandium during 1972. Supply was adequate for the small demand. The limited consumption and high production costs were expected to maintain high prices for marketable scandium products. Extraction of scandium from other sources, such as phosphate rock and tungsten concentrate, was not considered profitable.

Uses.—In addition to uses in research and development, scandium had two commercial applications. High purity scandium metal was used in the manufacture of high-intensity mercury lamps. These lamps were particularly useful for illumination of events televised in color because their illuminating efficiency and color range approached the qualities of sunlight. Radioisotope scandium-46 was used in tracing fluid flows in oil well reservoir studies and in evaluation of quality of casing cementations.

Prices.—The price of scandium oxide, 99.9%, as quoted by Research Chemicals, remained unchanged during the year at $2.80 per gram in lots of 100 to 453 grams; that of scandium metal in ingots and distilled forms was $8 and $15 per gram, respectively, while that of powder and chips remained unchanged at $10.35 per gram. Prices for scandium sheet foil were $17.85 to $105 per square inch for 51 to 100 square inch lots, ranging from 0.001 to 0.1 inch in thickness. Larger quantities were available for most items at lower prices.

Technology.—Most research remained aimed at a better understanding of properties and behavior of scandium in different environments. A limited number of projects were related to production of scandium metal and compounds. A process for recovering scandium from uranium waste liquors was developed using a three-phase system of an ion exchange resin, H_2SO_4 solution, and kerosene solution of bis (2-ethyl-hexyl) phosphate. Distribution of scandium in the system was tabulated. Selective scandium desorption is possible using this method.[14]

SELENIUM [15]

Domestic selenium production was 769,000 pounds, an increase of 17% from 1971. Shipments by domestic producers increased 19% to 791,000 pounds with the difference supplied from stocks which stood at 161,000 pounds at yearend. World production increased 5% to 2,642,000 pounds.

On August 11, 1971, Congress authorized disposal of the 474,774 pounds of selenium held in the national stockpile. No disposals were made during the remainder of 1971. During 1972 a total of 16,090 pounds of selenium was sold or exchanged for strategic commodities needed for the national stockpile.

Domestic Production.—Primary selenium was produced at four plants operated by the following major electrolytic copper refiners: American Metal Climax, Inc., Car-

[13] Prepared by Roman V. Sondermayer, physical scientist.

[14] Csovari, M., B. Szegedi, and I.A. Kuzin. Application of Three-Phase Systems in Chemical Technology. Pro. of 2d Conf. on Applied Phys. Chem., Budapest, Hungary, V.1, 1971, pp. 145–152.

[15] Prepared by Lyman Moore, mining engineer.

Table 8.—Salient selenium statistics

(Thousand pounds of contained selenium)

	1968	1969	1970	1971	1972
United States:					
Production	633	1,247	1,005	657	[1] 769
Shipments to consumers	941	1,429	1,056	663	[1] 791
Imports for consumption	583	546	454	395	430
Stocks, Dec. 31, producers	428	240	189	182	161
Producers price per pound, commercial and high-purity grades	$4.50–$6	$7–$8.50	$9–$10.50	$9–$11.50	$9–$11.50
World: Production	1,946	2,834	2,883	2,527	2,642

[1] Includes an estimated 30,000 pounds of selenium refined from secondary sources.

teret, N.J.; American Smelting and Refining Company, Baltimore, Md.; The Anaconda Company, Perth Amboy, N.J.; and Kennecott Copper Corp., Garfield, Utah. Crude materials containing primary selenium were transferred to these plants from copper refineries operated by Inspiration Consolidated Copper Co., Magma Copper Co., and Phelps Dodge Corp. An estimated 30,000 pounds of selenium was recovered by domestic secondary refineries from purchased electronic scrap. Considerable selenium home scrap was reused by manufacturers after outside reprocessing under toll contracts. Some domestic selenium-containing material was shipped to foreign plants for refining. High-purity selenium and various selenium compounds were produced by primary and other processors from commerical grade metal.

Consumption and Uses.—Apparent selenium consumption increased about 10% from 1971. Estimated usage in glass manufacturing, which consumed over one-third of the total metal used, increased over 15%. Small proportions of selenium compounds are added to glass melts to neutralize the green coloration caused by iron. Larger proportions are used to produce gray and bronze tinted window glass that reduces glare and heat transmission and to produce red- and amber-colored glass for signals and decorative uses. Consumption of selenium in xerography increased slightly during 1972 and this use now consumes about one-fourth of the primary metal shipped. More efficient use of selenium in xerographic copying machines and reclaiming of home scrap have restrained the consumption of primary selenium in xerography despite increasing use of copying machines. However, new applications in this field promise a larger future demand. Selenium consumption for rectifiers, photoelectric cells, and other electronic applications remained steady despite industry expansion, because of more efficient usage of selenium. Electronic uses consumed about one-fifth of the selenium marketed. Demand for selenium in pigments and steel alloys increased significantly. Other chemical, pharmaceutical, and miscellaneous uses were little changed from 1971.

Prices.—The producers' price for commercial and high-purity-grade selenium remained at $9 and $11.50 per pound, respectively, throughout the year, but there were periods of spot shortages and surpluses of metal. The merchant price for commercial grade was $9 to $9.30 during early 1972, slumped to below $8 in August and recovered to about $8.40 in November, and was $9 at yearend.

Foreign Trade.—Selenium exports rebounded from 1971 shipments which were unusually low because of the copper industry strike. The largest shipments were made to West Germany, the United Kingdom, and the Netherlands.

Selenium imports for consumption increased 9% and the value of imports increased 4%. Canada continued to be the principal supplier. Imports by country are shown in table 9.

World Review. The United States was the leading selenium producer, Japan was second, and Canada was third. These three countries accounted for 82% of world production (excluding the U.S.S.R.).

Technology.—The Selenium-Tellurium Development Association, Inc. continued sponsorship of research programs designed to increase selenium utilization.

United States animal feed processors have applied to the Food and Drug Administration for approval to add selenium to feed for poultry and swine. Research on animal nutrition has shown that, although food containing more than 3 parts per

Table 9.—U.S. imports for consumption of selenium, by country

(Thousand pounds and thousand dollars)

Country	Quantity	Value
	Unwrought, waste and scrap	
Australia	2	18
Canada	342	3,558
Germany, West	(1)	(1)
Japan	26	195
Mexico	28	176
Peru	1	10
Sweden	(1)	(1)
United Kingdom	5	54
Yugoslavia	4	28
Total	408	4,039
	Oxide (selenium content)	
Canada	18	183
Germany, West	(1)	1
United Kingdom	4	41
Total	22	225

[1] Less than ½ unit.

million (ppm) of selenium can be poisonous to swine and poultry, concentrations of up to 0.1 ppm are beneficial to swine and chickens and up to 0.2 ppm are beneficial to turkeys. Farm and laboratory animals whose diets are deficient in selenium are susceptible to serious disorders including muscular dystrophy and necrosis of the liver, kidneys, and pancreas. Selenium deficiency also makes animals highly vulnerable to poisoning from heavy metals such as mercury and lead. Selenium feed additions have long been used with good effect in Australia and New Zealand where the soil is notably lacking in selenium. The selenium content of U.S. soil varies considerably, ranging from dangerously high to inadequate. Studies are also in progress to determine optimum human selenium consumption and the present intake from food, air, and water.

Table 10.—Selenium: World refinery production by country [1]

(Thousand pounds)

Country [2]	1970	1971	1972 [p]
Australia [e]	[r] 7	7	7
Belgium-Luxembourg [3]	68	120	147
Canada	[r] 854	886	[4] 655
Finland	15	14	[e] 16
Japan	467	524	738
Mexico [5]	278	115	97
Peru	15	16	18
Sweden	139	[e] 134	[e] 140
United States	1,005	657	769
Yugoslavia	35	54	55
Total	[r] 2,883	2,527	2,642

[e] Estimate. [p] Preliminary. [r] Revised.

[1] Insofar as possible, data relate to refinery output of elemental selenium only; thus countries that produce selenium in copper ores and concentrates, blister copper, and/or refinery residues, but do not recover elemental selenium have been excluded to avoid double counting.

[2] In addition to the countries listed, West Germany and the U.S.S.R. are known to produce refined selenium and Zaire and Zambia may produce refined selenium, but available information is inadequate to make reliable estimates of output levels.

[3] Exports.

[4] Recoverable selenium content of blister copper treated at domestic refineries plus refined selenium from domestic raw materials, but excludes other unspecified materials that provide a portion of total refined selenium output. Corresponding figures for previous years in thousand pounds are: 1970—663; 1971—719.

[5] Figures represent mine output only, not refinery production.

TELLURIUM [16]

Domestic tellurium production of 257,000 pounds was the highest since 1962 and was 57% above the strike-reduced output of 1971. Domestic shipments of 271,000 pounds was a new record. Imports increased five times from those of 1971.

Domestic Production.—Production of tellurium was reported by the following major electrolytic copper or lead refiners: American Metal Climax, Inc., Carteret, N.J.; American Smelting and Refining Company, Baltimore, Md.; The Anaconda Company, Perth Amboy, N.J.; and United States Smelting Lead Refinery, Inc., East Chicago, Ind., division of UV Industries, Inc. Electrolytic refinery sludges containing primary tellurium were also produced at refineries operated by Inspiration Consolidated Copper Co., Kennecott Copper Corp., Magma Copper Co., and Phelps

[16] Prepared by Lyman Moore, mining engineer.

Dodge Corp. High-purity tellurium, tellurium master alloys, and tellurium compounds were produced by primary and intermediate processors from commercial-grade metal and tellurium dioxide.

Consumption and Uses.—Tellurium shipments for use as a free-machining agent in carbon and stainless steel and as a chilling agent in cast iron increased from the previous year and were about 60% of the total consumption. Reductions in consumer inventories that held down shipments in 1971 were completed and steel makers and machinery manufacturers increased purchases especially in the later part of the year. Consumption of tellurium in free-machining copper increased and was about 20% of consumption. About 11% was used in rubber manufacture, 6% in chemicals, and 3% in electronic and other uses.

Prices.—The producer price for commercial-grade powder and slab continued at $6 per pound throughout 1972, unchanged since 1962. Some discounting by merchants was reported during the first part of the year. Prices for high-purity grades of tellurium ranged from $10 to $32 per pound.

Table 11.—Salient tellurium statistics

(Thousand pounds of contained tellurium)

	1968	1969	1970	1971	1972
United States:					
Production, primary and secondary	121	234	158	164	257
Shipments to consumers	201	182	209	163	271
Stocks, Dec. 31, producers	157	177	128	r 116	102
Imports	71	112	64	30	146
Price per pound, commercial grade	$6	$6	$6	$6	$6
World: Production	258	395	367	340	422

r Revised.

Table 12.—U.S. imports for consumption of tellurium, by country

(Thousand pounds and thousand dollars)

Country	Quantity	Value
Canada	15	100
India	(1)	2
Peru	131	713
Total	146	815

1 Less than ½ unit.

Foreign Trade.—Imports in 1972 were 146,000 pounds compared with 30,000 pounds in 1971. Large shipments were received from Peru early in the year. The imported metal was nearly all of commercial grade and had an average value of $5.58 per pound. In accordance with the General Agreement on Tariffs and Trade, the effective import duty was reduced January 1, 1972, from 4.5% ad valorem on metal and 6.0% ad valorem on compounds to 4% and 5%, respectively.

World Review.—The United States continued to lead the world in tellurium output; Japan was second and Canada third.

Table 13.—Tellurium: World refinery production by country [1]

(Thousand pounds)

Country [2]	1970	1971	1972 p
Canada	r 65	44	3 48
Japan	78	79	77
Peru	r 66	53	e 40
United States	158	164	257
Total	r 367	340	422

e Estimate. p Preliminary. r Revised.

1 Insofar as possible, data related to refinery output only, thus countries that produce tellurium in copper ores and 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, West Germany and the U.S.S.R. are known to produce refined tellurium, and other countries such as Zaire and Zambia may produce refined tellurium, but available information is inadequate to make reliable estimates of output levels.

3 Includes recoverable tellurium content of blister copper treated at domestic refineries plus refined tellurium from domestic raw materials but excludes other unspecfied materials that provide a portion of total refined tellurium output. Corresponding figures for previous years in thousand pounds are: 1970—59; 1971—24.

THALLIUM [17]

Thallium and thallium compounds are limited as to both size of market and number of uses. Federal restrictions regarding use of some compounds deter the use of this rare metal.

Domestic Production.—The American Smelting and Refining Company, Denver, Colo., was the only domestic producer of thallium and thallium compounds. Metal production was up slightly over 1971, but shipments were down.

Uses.—Distribution of thallium consumption was about 40% for electronics, 30% for low-melting alloys, 10% for optical glass, 7% for agriculture, 3% for medicine, 5% for academic purposes and development research, and other uses about 5%.

Curtailment of thallium as a rodenticide by Government action is continuing with increasing controls resulting from an accidental killing of wildlife in 1971 in the West. On February 8, 1972, the President issued Executive Order 11643 which offers environmental safeguards on activities for animal damage control on Federal Lands. The policy of the order is to restrict the use of chemical toxicants for killing predatory mammals, birds, or reptiles, which may cause secondary poisoning of such animals on Federal Land, and the use of such toxicants in any Federal program of mammal or bird damage control.

Thallium has a significant use in the electronics industry for production of thallium-activated sodium iodide crystals and for the production of "thallofide" cells which contain thallium sulfide and are sensitive to infrared radiation. Some thallium compounds are extremely photosensitive especially to light of low intensity. Thallium is also used in low-melting alloys for switches, thermometers, and other instruments for protection against extreme Arctic temperatures. Further use of thallium is likely for reaction intermediates in a variety of syntheses where the oxidizing power of thallium (III) and the stability of thallium (I) derivatives are exploited.[18]

Prices.—The price of thallium in 25-pound lots has been $7.50 per pound since December 1957.

Foreign Trade.—U.S. imports for consumption in 1972 were 1,449 pounds of unwrought, and waste and scrap thallium valued at $3,940. The amount was about twice that imported in 1971. Thallium compounds imported were 936 pounds valued at $7,144.

[17] Prepared by Herbert R. Babitzke, physical scientist.

[18] Lee, A. G. The Chemistry of Thallium. Elservier Publishing Co., Ltd., Barking, Essex, England, Monograph 14, 1971, 336 pp.

Table 14.—U.S. imports for consumption of thallium in 1972, by country

Country of origin	Compounds (gross weight)		Unwrought, and waste and scrap	
	Pounds	Value	Pounds	Value
Belgium-Luxembourg	425	$1,468	1,000	$2,910
Canada	--	--	3	259
Germany, West	246	2,567	--	--
U.S.S.R.	--	--	446	771
United Kingdom	265	3,109	--	--
Total	936	7,144	1,449	3,940

Minor Nonmetals

By Staff, Division of Nonmetallic Minerals

CONTENTS

GREENSAND [1]

Greensand (glauconite, essentially a hydrous silicate of iron and potassium) was produced in 1972 only by Inversand Co., Clayton, N.J. Production and sales data are withheld to avoid disclosure of company confidential data. However, it may be of interest to know that the average annual production for the period 1967 to 1971 was 3,437 tons valued at $233,000. During this period, there were two producers of greensand.

Greensand was used by various water treatment manufacturers.

A cooperative agreement between the Bureau of Mines and the Delaware State Geological Survey to sample and evaluate Delaware greensand for potential uses was continued. Forty samples of greensand were analyzed and the results were being evaluated for additional work.

IODINE [2]

Consumption of crude iodine did not change appreciably from that of 1971, but there was a surplus for most of 1972. Industry stocks were particularly high in early 1972 because of record tonnages of iodine imported during the previous year in anticipation of higher prices. Domestic output which represented a small part of overall supply, increased somewhat compared with 1971, whereas imports declined by more than 1 million pounds.

Crude iodine production in the free world rose by possibly 700,000 pounds, or 3 to 4 percent, almost all accounted for by Japan, which more than made up for the slight decline in output by Chile, the world's second ranking iodine producer. Japanese iodine was priced at $1.86 per pound all year and Japan was the sole supplier of iodine to the United States. On the other hand, Chile was selling at $2.27 and, in effect, temporarily priced itself out of the U.S. market. Domestic iodine was also quoted at $2.27, but this did not cause difficulties in marketing, since the iodine was converted into downstream products before sale. At yearend, pressure was being built up for another round of upward evaluation of the Yen, which in turn would mean higher prices for Japanese iodine.

Legislation and Government Programs.—On December 31, 1972, the Government strategic stockpile contained 2,955,692 pounds of crude iodine, and the supplemental stockpile, 5,056,122 pounds for a total of 8,011,814 pounds. The stockpile objective for iodine, established by the Office of Emergency Preparedness, was reduced from 8 million to 7.4 million pounds in October. However, there were no stockpile withdrawals or deliveries of iodine in 1972.

---

[1] Prepared by Donald E. Eilertsen, physical scientist.
[2] Prepared by K. P. Wang, physical scientist.

Table 1.—Crude iodine consumed in the United States

Products	1971			1972		
	Number of plants	Crude iodine consumed		Number of plants	Crude iodine consumed	
		Thousand pounds	Percent of total		Thousand pounds	Percent of total
Resublimed iodine	5	W	W	6	600	11
Potassium iodide	6	1,612	34	10	1,514	29
Sodium iodide	4	W	W	4	90	2
Other inorganic compounds	15	1,209	25	14	983	19
Organic compounds	21	1,980	41	19	2,071	39
Total	[1] 34	[2] 4,802	100	[1] 30	[2] 5,258	100

W Withheld to avoid disclosing individual company confidential data; included with "Other inorganic compounds."
[1] Nonadditive total because some plants produce more than one product.
[2] Data may not add to totals shown because of independent rounding.

Depletion allowance for domestic iodine producers was changed under terms of the Tax Reform Act of 1969. Effective with taxable years beginning after October 9, 1969, the depletion allowance for iodine from both domestic and foreign production is 14 percent of gross income, not to exceed 50 percent of net income without the depletion deduction.

Domestic Production.—The Dow Chemical Co., the only domestic producer, recovered crude iodine from well brines at Midland, Mich. as a coproduct with bromine, calcium, and magnesium compounds. Compared with that of 1971, quantity of output increased by approximately 3 percent, and value, 12 percent.

Consumption and Uses.—Based upon returns from questionnaires, approximately 5.26 million pounds of crude iodine was consumed by 30 firms in 12 States. Leading iodine-consuming States in 1972, in descending order of magnitude, were Missouri, New York, New Jersey, and Pennsylvania, which together accounted for more than four-fifths of the total crude iodine consumption.

The above information is indicative of the consumption pattern but is not necessarily completely comprehensive. Iodine and iodides employed as catalysts and in "dissipative" uses in general, particularly in making synthetic rubber, are not well covered. Imports alone have been consistently higher than reported consumption, with net differences as follows, in thousand pounds: 1970, 981; 1971, 2,473; and 1972, 949. A more exact estimate of apparent consumption cannot be published as U.S. production figures for crude iodine cannot be revealed.

Iodine consumed in making immediate downstream products, such as resublimed iodine, potassium iodide, sodium iodide, and organic iodine-containing compounds, have not shown any radical changes in recent years. As for ultimate downstream uses, the major categories in 1972 were roughly as follows, in order of descending importance: catalysts (in rubber), food supplements, stabilizers (in nylon), inks and colorants, pharmaceuticals, sanitary uses, and photographic uses.[3] Iodine was also consumed in making high-purity metals, motor fuels, iodized salt, smog inhibitors, swimming pool sanitizers, and lubricants.

Prices.—There were very few price changes in 1972, although by yearend higher prices were imminent for Japanese iodine, which eventually went up to $2.06 per pound around mid-February 1973. U.S. and Chilean iodine were quoted at $2.27 all year. As usual, prices had little to do with supply and demand, since an oversupply situation was accompanied by high prices. Quoted prices for iodine and iodine compounds at yearend 1972 were as follows, per pound.

	Per pound
Crude iodine, drums	$1.86–$2.27
Resublimed iodine, U.S.P., drums, f.o.b. works	3.97– 4.00
Calcium iodate, drums, delivered	2.50– 2.80
Calcium iodide, 35-pound drums, f.o.b works	5.98
Potassium iodide, U.S.P., crystals, drums, 300 to 999 pounds, delivered	2.60– 2.95
Potassium iodide, U.S.P., crystals, drums, smaller lots, delivered	2.75– 2.95
Sodium iodide, U.S.P. crystals, 300-pound drums, freight equalized	3.50– 3.63

Source: Chemical Marketing Reporter.

[3] Chemcial Marketing Reporter (New York). V. 203, No. 10, Mar. 5, 1973, pp. 3 and 23.

Foreign Trade.—Crude iodine imported into the United States in 1972 declined by nearly 15 percent in quantity compared with that of 1971, but total value decreased only 12 percent. The average value of imported crude iodine rose from $1.58 per pound in 1971 to $1.64 per pound in 1972. About 6.2 million pounds of crude iodine was imported, all from Japan. Imports of resublimed iodine were nominal compared with imports of crude iodine.

Tariff rates remained at 5 cents per pound on resublimed iodine and 12 cents per pound on potassium iodide. Crude iodine enters the United States duty free.

Table 2.—U.S. imports for consumption of crude iodine, by country

(Thousand pounds and thousand dollars)

Country	1970		1971		1972	
	Quantity	Value	Quantity	Value	Quantity	Value
Chile	1,723	2,076	2,950	5,679	--	--
Japan	4,320	4,758	4,325	5,831	6,207	10,184
Total	6,043	6,834	7,275	11,510	6,207	10,184

World Review.—*Chile.*—Production of crude iodine in 1972 as a byproduct of nitrates probably was just under 2,500 short tons. Output was on the low side for Chile, but even the upper limit would not be much more than 3,000 short tons per year because of limitations related to extraction of coproduct nitrates.

Chile's three iodine plants owned by Sociedad Química y Minera de Chile, S.A. (SOQUIM), namely Valdivia, Victoria, and Elena, were operated nearly full-scale during the year. Valdivia the most modern and largest plant, had not fully recovered from an over $2 million fire in October 1971 and was producing at only 70 percent capacity at yearend 1972.

At $2.27 per pound, which was much higher than the Japanese price, Chile was not able to sell any iodine during 1972 in the sluggish U.S. market. It appeared also that this price was not necessarily adequate to cover cost, which had gone up sharply since the fire. Stocks were building up, and Chile's 1972 iodine sales were confined mainly to Eastern European, Western European, Latin American countries, and the Peoples Republic of China. A new price policy apparently was being considered late in the year.

Japan.—Japan strengthened its position as the world's foremost iodine producer during 1972. Its output of 8,240 short tons of crude iodine, an increase of about 11 percent over the 7,423 tons produced in 1971, was more than three times that of Chile, the only other major free world producer. Over four-fifths of the Japanese production was exported, principally to the United States, which took about 3,103 short tons in 1972. Japan's other iodine markets included Common Market countries, United Kingdom, India, the People's Republic of China, and Canada.

Japan's iodine was produced from natural gas brines by five manufacturing groups operating 18 plants. About five of the plants have been built since 1970.

As of yearend 1972, crude iodine capacity of Japan was about 650 tons per month. Ise Chemical Industries, Ltd. (Ise Chemical), was by far the leading firm, with roughly one-half of the country's capacity. It owns seven plants and produced 25 tons monthly for Teikoku Oil Co. Ltd (Teiseki) and 12 tons monthly for United Resources (Godo). Godo's two plants accounted for about one-fifth of Japan's capacity. Nippon Tennen (Nitten) with three plants and Kantoh Tennen (Kanten) with four plants each had just over one-tenth of the total capacity. The rest was owned by two sister companies—Nippon Chemical Industries and Nippon Halogen, each with one plant.

Japan's iodine producers continued to pay large dividends because of good prices. The Japan Iodine Export Corp. held down the price in the United States at $1.86 per pound despite the fact that Chilean and U.S. producers had been selling crude iodine at a much higher price during 1972. Japanese iodine prices were increased in early 1973 to a level still below its competitors. Recent price increases in Japanese iodine did not mean any benefits to the producers, however, as these were totally linked to the upward revaluation of the Yen, which remained the same in value within Japan.

The outlook for the Japanese iodine industry was not as bright as a few years ago, principally because the recent and projected price increases weaken the Japanese position and the competitive status of iodine as a commodity. The reserve picture remained essentially the same, although it would improve under conditions of high price and better technology. Japan had enough iodine in its natural gas to support recent production levels indefinitely. Output of iodine had already risen 28 percent in 1970, 14 percent in 1971, and another 11 percent in 1972. Despite subsidence and pollution difficulties in some Chiba operations, Japanese iodine production is likely to increase somewhat in the next few years, in view of the relatively low-cost resources, the steady growth in world demand, and the probability that Chilean output would not surpass historic peak levels. However, the ecological problem has become increasingly troublesome, and long-term output potential can be seriously affected. Ground control and waste disposal regulations are expected to be more strict, and reinjection of fluids into the ground is not always feasible. Only Ise Chemical has plants in new areas satisfying environmental guidelines along with the potential for substantial expansion. Ise Chemical had been investigating iodine resources in Indonesia and could eventually initiate production there under appropriate conditions.

U.S.S.R.—Soviet production of iodine has been estimated at 1.1 million pounds for 1966 and 3.3 million pounds for 1971, derived from the Neftechlinski field and the Slavyansko-Troitskoe area near the Black Sea.[4]

LITHIUM[5]

Domestic output of lithium minerals and lithium carbonate from brines increased substantially over that of 1971 and was the largest ever reported. Imports for consumption of lithium minerals were only about one-fifth the quantity imported in 1971.

Legislation and Government Programs.—The ad valorem tariff on lithium metal was 12.5% and on lithium compounds 5% during 1972; lithium minerals concentrates are imported duty free. At yearend 6,490 short tons of lithium hydroxide monohydrate were held by General Services Administration under the Federal Property Act.

Domestic Production.—Foote Mineral Co. mined and milled spodumene from pegmatites at Kings Mountain, N.C., and also recovered lithium carbonate from brines at Silver Peak, Nev. Lithium Corp. of America, a subsidiary of Gulf Resources and Chemical Corp., mined and milled spodumene near Bessemer City, N.C.; Kerr-McGee Corp. recovered lithium carbonate from brines at Trona, Calif.

Foote Mineral Co. completed expansion of its lithium carbonate production capacity at Silver Peak, Nev., during the year and construction of a commercial, low-iron spodumene facility at Kings Mountain, N.C., was completed in December.[6]

Processors of lithium raw materials to lithium primary products were Foote Mineral Co., Sunbright, Va., and Silver Peak, Nev., Kerr-McGee Corp., Trona, Calif., and Lithium Corp. of America, at Bessemer City, N.C. Production data were not available for publication.

Consumption and Uses.—Domestically produced lithium minerals were processed into numerous lithium chemicals for a wide variety of applications. Major uses were in primary aluminum production, ceramics, greases, air conditioning, alloying, welding and brazing, swimming pool sanitation, and organic synthesis.

Although consumption of most lithium compounds increased during the year, sales of lithium carbonate to the aluminum industry continued to show the most significant increase.

Humble Oil & Refining Co. announced the development of a new generation of lithium-soap greases. The new multipurpose products are said to offer extended

[4] Page 23 of work cited in footnote 3.
[5] Prepared by Donald C. Wininger, physical scientist.
[6] Foote Mineral Co. 1972 Annual Report, p. 3.

life at high temperatures and also function well at subzero temperatures. Recommended industrial applications include oven conveyor bearings, dryer roll bearings, rotary steam joints, kiln car bearings, induced-draft fan bearings, other equipment subjected to high radiant heat, and lubricated-for-life bearings.[7]

Prices.—Domestic prices of lithium minerals are usually determined by direct negotiation between buyer and seller and are seldom published. However, the January 1972 issue of Ceramic Industry listed prices for spodumene supplied to the ceramic industry ranging from $77 to $89.50 per ton, compared with $71 to $84 quoted in 1971. The following prices[8] for lithium minerals per short ton unit Li_2O, concentrate, c.i.f. main European port were listed in the December 1972 issue of Industrial Minerals:

Amblygonite, 6–8% Li_2O (basis 8%)	$14.46–16.61
Lepidolite, 3–3.5% Li_2O (basis 3%)	$15.00–15.54
Petalite, 3.5–4.5% Li_2O (basis 3%)	$9.64–11.79
Spodumene, 4–7% Li_2O (basis 6%)	$11.04–12.86

Prices for the major lithium compounds at yearend were quoted in the Chemical Marketing Reporter as follows:

	Per pound
Lithium metal, 1,000-pound lots or more, delivered	$8.18
Lithium bromide, anhydrous, drums, ton lots, delivered	1.70
Lithium carbonate, carlots, truck loads, delivered, in drums	.525
Lithium chloride, anhydrous, carlots, truck loads, delivered, in drums	.91
Lithium fluoride, carlots, truck loads, delivered in drums	1.58–1.59
Lithium hydride, carlots, truck loads, delivered	8.05
Lithium hydroxide, monohydrate, carlots, truck loads, delivered, in drums	.63
Lithium nitrate, technical, 100-pound lots, in drums	1.25–1.55
Lithium stearate, 50-pound cartons, carlots, works, freight allowed	.58
Lithium sulfate, 100-pound lots, in drums	1.20–1.30

Foreign Trade.—Exports of lithium hydroxide increased from 478,239 pounds valued at $244,834 in 1971 to 1,097,175 pounds valued at $595,232 in 1972. Quantitative data on exports of lithium minerals and lithium metal, alloys, and other compounds were not available. Domestic imports of lithium minerals were only 19% of the 1971 level. Australia was the only source of imported ores during 1972. Imports of lithium compounds were 36,791 pounds valued at $69,291, principally from the U.S.S.R. (62%), France (36%), and small amounts from Ireland, Japan, the United Kingdom, and West Germany.

World Review.—*Canada.*—The Chemalloy Minerals subsidiary, Tantalum Mining Corp. of Canada, Ltd. obtained a loan from the Manitoba Development Corp., which will be used to construct a mill for the production of lithium concentrates. Initial plans are for the construction of a 150-ton-per-day pilot mill at the Bernic Lake mine site. If the results of this work are favorable, the plant will be expanded to between 350 and 450 tons per day.[9]

The stronger lithium carbonate and hydroxide market worldwide has prompted the Sullivan Mining Group to consider reopening its Barrute lithium mine. The mine, formerly operated under the name Quebec Lithium, has been on a care-and-maintenance basis since 1966 when it was closed due to a drop in the price of lithium carbonate and a strike for higher pay by mine employees.[10]

Italy.—Montecatini Edison S.p.A. (Montedison), which formerly manufactured lithium compounds from spodumene, has discontinued production for economic reasons.[11]

[7] American Metal Market. Humble Unveils Lithium Grease. V. 79, No. 70, Apr. 11, 1972, p. 12.
[8] Converted at the rate, 1£=$2.40.
[9] The Northern Miner. Chemalloy's Tanco Gets Loan to Build Mill for Lithium. V. 57, No. 49, Feb. 24, 1972, p. 1.
[10] Engineering and Mining Journal. V. 173, No. 1, January 1972, p. 152.
[11] Engineering and Mining Journal, Lithium. V. 174, No. 3, pp. 120–121.

Table 3.—U.S. imports for consumption of lithium ore, by country of origin and U.S. customs district

Country and customs district	1971 Short tons	1971 Value (thousands)	1972 Short tons	1972 Value (thousands)
Australia: Baltimore	--	--	1,215	$33
Brazil: Baltimore	5,292	$442	--	--
South Africa, Republic of: Baltimore	1,115	83	--	--
Total	6,407	525	1,215	33

Table 4.—Lithium minerals: World production, by country

(Short tons)

Country [1]	Mineral produced	1970	1971	1972 p
Argentina	not specified	270	89	e 90
Australia	do	864	1,846	e 1,900
Brazil [2]	do	4,025	NA	NA
Canada [3]	spodumene	467	NA	NA
Mozambique	lepidolite [4]	41	NA	NA
Portugal	lepidolite	276	827	1,323
Rhodesia, Southern [5]	not specified	67,000	67,000	67,000
South Africa, Republic of	spodumene	10	1	--
South-West Africa, Territory of [6] e	do	7,616	8,909	[7] 5,881
United States	not specified	W	W	W

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

[1] In addition to the countries listed, others (notably the U.S.S.R.) may produce lithium minerals, but available information is inadequate to make reliable estimates of output levels.

[2] Exports.

[3] United States imports from Canada.

[4] Includes amblygonite as follows, in short tons: 1970—14; 1971—NA; 1972—NA.

[5] Output has not been reported since 1964, but presumably has continued. Figures given are simply the 1964 output level rounded to the nearest thousand tons and are presented only to indicate order of magnitude of previous production, there being no assurance that the output level has not varied (footnote 6). In 1964, total reported production was distributed as follows by mineral, in short tons: eucryptite—806; lepidolite—22,943; petalite—36,449; spodumene—6,965.

[6] Output has not been reported since 1966, but presumably has continued, inasmuch as a number of countries record imports from "South Africa," which in total considerably exceed reported output of the Republic of South Africa. Estimates given represent total reported imports from "South Africa" by the United States and the European Economic Community less the reported output of the Republic of South Africa. These quantites, however, may include significant amounts originating in Southern Rhodesia (footnote 5) rather than in the Territory of South-West Africa. In 1966, total reported production was distributed as follows, by mineral, in short tons: amblygonite—30; lepidolite—365; petalite—1,344.

[7] Imports by United States, West Germany, and Netherlands only (footnote 6).

Technology.—Interest continued to build in the development of a lithium-sulfur battery. Results of some of the various ongoing research projects relating to battery development being conducted were reported during the year.[12]

In February, Lockheed Missiles & Space Co., Palo Alto, Calif., announced the development of a battery fueled with water and a light alkali metal such as sodium or lithium. The firm claims that pound-for-pound it produces from 10 to 100 times more electricity than the commonly used lead acid battery. Lockheed says the new battery potentially is the answer for pollution-free electric autos.[13]

The use of Raman powder spectroscopy for determing solid solubility of lithium niobate and lithium tantalate was reported.[14] The results of the study are said to have important implications concerning the conditions under which crystal growth of these materials can be conducted.

Bell Laboratories has developed a clear lithium tantalate crystal, which is claimed to be the first practical alternative to quartz crystal filters in communications equipment. The crystal is being produced in Andover, Mass., at the Merrimack Valley works of the Western Electric Co.[15]

A technique to improve the reliability and durability of ceramic sonar transducers has been developed by scientists at the Naval Research Laboratory in Washington, D.C. Investigators found that small additions of lithium fluoride to barium titanate improved densification. Increases in strength of 50% and 200% were achieved when the lithium fluoride was combined with comparable additions of magnesium oxide.[16]

A report of recent studies indicates that the addition of lithium to aluminum-mag-

---

12 Chemical Week. Researchers Add Lithium's Punch to Batteries. V. 110, No. 21, May 24, 1972, p. 55.
Cunningham, P. T., S. A. Johnson, and E. J. Cairns. Phase Equilibria in Lithium-Chalcogen Systems. J. Electrochem. Soc., v. 119, No. 11, November 1972, pp. 1448–1450.
Fishwick, J. H., and W. C. T. Yeh. Ceramic Separators for a High Temperature Lithium Battery. Am. Ceram. Soc. Bull., v. 51, No. 8, August 1972, pp. 633–636.
Salihi, Jalal T. Two for the road. IEEE Spectrum, v. 9, July 1972, pp. 43–47.
Sharma, Ram A. Equilibrium Phases in the Lithium-Sulfur System. J. Electrochem. Soc., v. 119, No. 11, November 1972, pp. 1439–1443.

13 Chemical Marketing Reporter. Sodium, Lithium Batteries Brought Out by Lockheed. V. 201, No. 9, Feb. 28, 1972, p. 7.

14 Scott, B. A., and G. Burns. Determination of Stoichiometry Variations in $LiNbO_3$ and $LiTaO_3$ by Raman Powder Spectroscopy. J. Amer. Ceram. Soc., v. 55, No. 5, May 1972, pp. 225–229.

15 American Ceramic Society Bulletin. Bell Producing Crystal. V. 51, No. 9, September 1972, p. 732.

16 Ceramic Industry Magazine. NRL Improves Ceramic Sonar Transducers. V. 99, No. 6, December 1972, p. 12.

nesium alloys may lower the density by as much as 10% while maintaining a high strength.[17]

The advantages of adding lithia to glass batches were reported on during the year.[18] Increased productivity without deteriorating the quality of the glass or shortening the life of the furnace was claimed. Reduced viscosity was said to be obtained at lower melting temperatures thus lowering fuel consumption and stack emissions. The savings of increased productivity and yielded longer furnace life, and improved product quality more than offset the added raw material costs.

MEERSCHAUM [19]

The quantity of meerschaum imported in 1972, primarily for domestic use in pipes and cigarette holders, declined sharply (36%) for the second straight year. United States imports for consumption totaled 11,139 pounds valued at $22,791, compared with 17,482 pounds valued at $25,825 in 1971. Sources of U.S. imports of meerschaum in 1972 were Belgium and Luxembourg, Japan, and Turkey.

QUARTZ CRYSTAL [20]

ELECTRONIC-GRADE

Total raw quartz crystal consumption increased 42% over that of 1971. The consumption of manufactured quartz continued to exceed that of natural quartz, but the consumption of both categories increased. Imports of electronic-grade material almost doubled that of 1971. Exports of both natural and manufactured material declined. The production of finished crystal units increased 22% to almost 25.6 million units.

Legislation and Government Programs.—The Government maintained a stockpile objective of 320,000 pounds of electronic-grade quartz crystal. Sales of excess material were continued by the General Services Administration. At yearend the Defense Materials Inventory declined slightly from the previous year to 4.34 million pounds of stockpile-grade material and 352,960 pounds of nonstockpile-grade material.

Domestic Production.—No production of natural electronic-grade quartz crystal was reported during 1972. At yearend, six companies reported production of manufactured quartz for use by the quartz crystal cutting industry. These companies were P.R. Hoffman Co., Carlisle, Pa.; Motorola, Inc., Chicago, Ill.; Quality Crystals, Inc., Cortland, Ohio; Sawyer Research Products, Inc., Eastlake, Ohio; Thermodynamics Corp., Shawnee Mission, Kans.; and Western Electric Co., Inc., North Andover, Mass. The firms producing manufactured quartz remained unchanged from the previous year. Manufactured quartz production increased 45% from the quantity reported in 1971 to 159,825 pounds.

Consumption and Uses.—Total raw crystal consumption increased significantly from 132,739 pounds in 1971 to 189,078 pounds in 1972. Consumption of natural quartz increased 41% from 61,784 pounds in 1971 to 87,157 pounds in 1972. Manufactured quartz consumption increased 44% from 70,955 pounds in 1971 to 101,921 pounds in 1972. The consumption of manufactured quartz exceeded that of natural quartz for the second consecutive year. The number of finished crystal units fabricated from the raw quartz consumed during the year reached almost 25.6 million units. The 1972 consumption data reported in table 5 are based on reports received from 28 crystal cutters in 12 States. Finished piezoelectric units were produced by 24 of the cutters; the remainder produced only semifinished blanks. Of these cutters 2 consumed natural quartz only, 14 manufactured quartz only, and 12 cut both natural and manufactured quartz.

---

[17] Materials Engineering. Lithium Good Prospect to Strengthen Al-Mg Alloys. V. 75, No. 2, February 1972, p. 19.

[18] Fishwick, John H. Melting and Firing Times. The Glass Industry, Lithia Reduces Viscoscity. V. 53, No. 9, September 1972, pp. 10, 15.

———. The Glass Industry. Lithia Doping. V. 53, No. 10, October 1972, pp. 16–17.

[19] Prepared by Arthur C. Meisinger, industry economist.

[20] Prepared by Benjamin Petkof, physical scientist.

Table 5.—Salient electronic- and optical-grade quartz crystal statistics

(Thousand pounds and thousand dollars)

	1970	1971	1972
Production of manufactured quartz	131	110	160
Imports of electronic- and optical-grade quartz crystal			
Quantity	94	35	65
Value	100	76	78
Exports of electronic- and optical-grade quartz crystal			
Quantity	286	174	149
Value	1,123	1,626	1,228
Natural:			
Quantity	231	113	90
Value	396	833	587
Manufactured:			
Quantity	55	61	59
Value	727	793	641
Consumption of raw electronic-grade quartz crystal	165	133	189
Natural	98	62	87
Manufactured	67	71	102
Production, piezoelectric units, number	18,971	20,924	25,555

Thirteen consumers in four States accounted for almost 90% of the raw quartz crystal consumption. Pennsylvania was the leading quartz-consuming State with 46% of the total, followed by Illinois, Kansas, and Missouri. Piezoelectric units were manufactured by 34 producers in 15 States. Eleven of these producers worked from partially processed quartz crystal blanks and did not consume raw material. Twelve plants in four States, Kansas, Illinois, Pennsylvania, and Missouri, supplied 77% of the total output of finished crystal units. Oscillator plates comprised 81% of production. The remainder included filter plates, telephone resonator plates, and other micellaneous items.

Stocks.—At yearend, stocks of raw quartz crystals held by consumers totaled 96,133 pounds. Of this total 73,832 pounds was natural material, and the remainder was manufactured quartz.

Foreign Trade.—The imports of electronic- and optical-grade quartz crystal, valued at more than $0.50 per pound, increased in both quantity and value in 1972 to 65,135 pounds and $78,462, respectively. This was an 86% increase in quantity but only 3% in value from the previous year's totals. The average value of imports was $1.20 per pound, a sharp decline from the previous year's average value of $2.17 per pound. Brazil supplied 91% of the total imports of electronic-grade material. The remainder was supplied by the United Kingdom and West Germany. The quartz crystal imported from these countries probably originated in Brazil.

A total of 684,617 pounds of lasca valued at $252,531 was inported in 1971, a decline of 5% in quantity and 13% in value from 1971 figures. Lasca was used to produce fused quartz and as a nutrient material for the manufacture of quartz crystal. Brazil provided 98% of total imports, and the remainder was shipped from West Germany and Japan.

U.S. exports of natural quartz crystal declined 20% from 112,560 pounds in 1971 to 90,246 pounds in 1972. Exports of manufactured quartz declined slightly from 60,750 pounds in 1971 to 58,914 pounds in 1972. The average price of natural quartz exported was $6.51 per pound; that of manufactured quartz was $10.89 per pound.

World Review.—*Brazil.*—The Nation maintained its position as the dominant world producer of electronic-grade quartz crystal and lasca. Exports of quartz crystal suitable for electronic use totaled 152,000 pounds valued at $279,000 in 1971. In addition, almost 10 million pounds of lasca valued at $2.33 million was exported.

Technology.—Two reports of experimental work have been published relating the quality of quartz crystal to infrared absorption.[21] A new method was described using a strain gauge to measure the mechanical strain in quartz crystals under the influence of an applied d.c. field. The pie-

[21] Sawyer, B. Q Capability Indications From Infrared Absorption Measurements for Na_2CO_3 Process Cultured Quartz. IEEE Trans. on Sonics and Ultrasonics, v. SU-19, No. 1, Jan. 1972, pp. 41–44.

Asahara, J., and S. Taki. Physical Properties of Synthetic Quartz and Its Electrical Characteristics. Proceedings 26th Annual Symposium on Frequency Control, June 6–8, 1972, pp. 93–105.

zoelectric constants increased with the applied voltage. These measurements were used to determine the quality of raw uncut quartz crystals.[22]

STAUROLITE [23]

Staurolite is a complex iron-aluminum silicate of uncertain and most likely variable composition. The mineral occurs as reddish-brown to black crystals with a specific gravity ranging from 3.65 to 3.77 and between quartz and topaz in hardness (7 to 8 on Moh's scale). Aside from a small rock-shop trade in cruciform-twinned crystals from some deposits ("fairy crosses") that are sold as curiosities or amulets, staurolite is produced commercially in the United States only in the form of a magnetic fraction of the heavy-mineral concentrate recovered by E. I du Pont de Nemours & Co. from a beach sand deposit in Clay County, Fla. Formerly the staurolite fraction was used only in some portland cement mixtures, but more recently this product (with minor admixtures of kyanite, quartz, rutile, spinel, tourmaline, and zircon, and averaging 45% Al_2O_3 and 15% Fe_2O_3) is being marketed under two trade names either for use as a sandblast abrasive or to be mixed with bentonite and other substances to serve as a foundry sand in some specialized molding applications. Increasing industrial demand for these products can be inferred from the observation that the ratio of staurolite shipments to staurolite production (which averaged around 50% in the 1965 to 1969 period) has been substantially in excess of 100% in each of the last 3 years. Quantitative production and shipment data are not released for publication, but the 1972 staurolite output was 4% below that of 1971, while shipments increased fractionally in tonnage and 11% in total value.

STRONTIUM [24]

Legislation and Government Programs.—Government stockpiles contained 12,062 tons of stockpile-grade and 13,787 tons of nonstockpile-grade celestite at yearend. The General Services Administration again offered the celestite for sale, however, no acceptable bids were received during the year.

Domestic Production.—Strontium minerals have not been produced commercially in the United States since 1959. However, a number of firms produced various strontium compounds from imported celestite. Sherwin-Williams Co., Ashtabula, Ohio, discontinued production of strontium carbonate at the end of August.

Consumption and Uses.—Domestic consumption of celestite in the manufacture of various strontium chemicals declined from the 1971 high. Quantitative information concerning consumption is incomplete, however, production of strontium carbonate was 15,476 short tons, compared with 19,350 tons produced in 1971. Sales of domestically produced strontium carbonate to manufacturers of glass for color television picture tubes totaled 15,030 short tons, a 3% decrease from those of 1971. Consumption of celestite in the manufacture of chemicals for pyrotechnics was not available.

Miscellaneous chemical applications for strontium compounds included ferrites, greases, ceramics, plastics, toothpaste, pharmaceuticals, paint, and electronic components. Small quantities of strontium metal were produced for use primarily by research companies. King Laboratories, Inc., Syracuse, N.Y., consumed a small quantity of metal to produce getter alloys used in the manufacture of vacuum tubes.

Prices.—At yearend, prices quoted in the Chemical Marketing Reporter were as follows: strontium carbonate:—technical, bags, carlots, works, at 13 to 21 cents per pound; and strontium nitrate:—bags, carlots, works, at $15 per 100 pounds, unchanged from the previous year. Prices for strontium minerals are usually determined by direct negotiation between buyer and seller and are seldom published. However,

[22] Parshad, R., and V. R. Singh. Observations on the Mechanical Strain in Quartz Crystals Under Electric Field Using Strain Gauge Instrumentation and Their Application for Determining the Goodness of Raw Quartz Crystals. Proceedings 26th Annual Symposium on Frequency Control, June 6–8, 1972, pp. 104–105.

[23] Prepared by J. Robert Wells, physical scientist.

[24] Prepared by Donald C. Wininger, physical scientist.

Table 6.—Major producers of strontium compounds, 1972

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.
E.I. du Pont de Nemours & Co. Inc	Grasselli, N.J	Nitrate.
FMC Corp	Modesto, Calif	Carbonate, hydrate, 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.
N L Industries, Inc., Tam Div	South Amboy, N.J	Titanates.
Sherwin-Williams Co	Ashtabula, Ohio	Carbonate.

Table 7.—U.S. imports for consumption of strontium minerals[1] by country

Country	1971		1972	
	Short tons	Value (thousands)	Short tons	Value (thousands)
Mexico	35,621	$812	27,791	$721
Spain	4,464	97	--	--
United Kingdom	5,420	206	2,886	109
Total	45,505	1,115	30,677	830

[1] Strontianite or mineral strontium carbonate and celestite or mineral strontium sulfate.

Table 8.—U.S. imports for consumption of strontium compounds, by country

Country	1971		1972	
	Pounds	Value	Pounds	Value
Strontium carbonate, not precipitated:				
Canada	--	--	68,300	$43,703
West Germany	--	--	10,098	3,700
Total	--	--	78,398	47,403
Strontium carbonate, precipitated:				
Canada	8,000	$800	405,850	40,802
Strontium chromate:				
Norway	25,000	5,525	--	--
United Kingdom	--	--	4,409	2,250
West Germany	16,000	6,975	5,004	2,471
Total	41,000	12,500	9,413	4,721
Strontium nitrate:				
Canada	68,200	7,664	605,100	76,580
United Kingdom	--	--	1,000	1,029
West Germany	1,102	556	441	254
Total	69,302	8,220	606,541	77,863
Strontium compounds, n.s.p.f.:				
France	5,511	7,970	4,409	6,828
West Germany	92,010	18,947	179,361	39,734
Total	97,521	26,917	183,770	46,562
Grand total	215,823	48,437	1,283,972	217,351

the December 1972 issue of Industrial Minerals listed the following price for British celestite: ground, washed and graded, 95% $SrSO_4$, bulk, exworks, 240-mesh $47.90 per short ton[25] the average value of imported strontium minerals at foreign ports was about $27 per short ton.

Foreign Trade.—Imports of strontium minerals totaled 30,677 tons, a 33% decline from the 1971 high. The material was imported from Mexico and the United Kingdom. Imports of strontium compounds increased six times over those of 1971 with most of the material coming from Canada (84%). Quantitative data on U.S. exports of strontium compounds were not available.

[25] Pound Sterling at US$2.40.

Table 9.—Strontium minerals: World production by country

(Short tons)

Country [1]	1970	1971	1972 [p]
Algeria	--	390	2,084
Argentina	470	2,356	[e] 2,400
Canada [e]	18,000	60,000	65,000
Iran [2]	330	330	[e] 330
Italy	931	920	810
Mexico	[r] 28,009	38,650	[3] 27,791
Pakistan	151	447	378
Spain	7,716	9,370	[e] 11,000
United Kingdom	[r] 10,473	[e] 9,000	[e] 9,000
Total	66,080	121,463	118,793

[e] Estimate. [p] Preliminary. [r] Revised

[1] In addition to the countries listed, West Germany, Poland, and the U.S.S.R. produce strontium minerals, but available information is inadequate to make reliable estimates of output levels.

[2] Year beginning March 21 of that stated.

[3] U.S. imports from Mexico.

World Review.—*Canada.*—Kaiser Strontium Products Ltd. began full scale worldwide marketing of strontium chemicals from its new plant at Point Edward, Cape Breton Island, Nova Scotia. Startup problems, however, delayed commercial-scale production of glass-grade strontium until the later part of the year.

Turkey.—A large deposit of high-grade, good-quality celestite has been discovered about 15 miles south of Siuas. Shipments to Europe and elsewhere are anticipated to commence in the near future.[26]

Technology.—A number of papers were presented at the annual meeting of the American Ceramic Society, concerning research on various strontium compounds, which may have electrical or electronic applications.[27]

The results of experiments on the formation of thin layers of mixed titanates including strontium by solid-solid reactions were reported. Possible application in devices such as delay lines, slow wave structures, and optical modulators was suggested.[28]

WOLLASTONITE [29]

Wollastonite, occurring naturally in certain deposits with a purity exceeding that of most other industrial minerals, is a crystalline calcium metasilicate that is finding increasing acceptance by industry as an ingredient with many advantages in ceramic body mixes, glazes, and enamel frits; as a filler for plastics, rubber, and asphalt products; as a pigment and extender for paints; in welding as a flux and rod coating; and presumably in a number of other applications still too new to have become generally known.[30]

Wollastonite was produced in the United States in 1972 from one open-pit mine operated by Interpace Corp. at Willsboro, Essex County, N.Y. Output from that mine was 35% greater in tonnage than in 1971, and the corresponding total value was 57% higher. Both figures represented new alltime highs for the New York mine, and it is notable that the tonnage was only 10% below the record national total of 1966 (when California also made a substantial contribution), and that the 1972 total value was also an alltime national high, 22% above that of 1966.

Wollastonite prices per short ton, works, were quoted in the Chemical Marketing Reporter on December 25, 1972, as follows: fine, paint-grade, bags, carlots, $43.80; and medium, paint-grade, bags, carlots, $33.00. These quotations were unchanged from those of the previous year. For the most part, actual sales were arranged as usual at negotiated prices not on public record.

A number of raw materials (including wollastonite, pyrophyllite, and clays), as well as the technologically advanced methods and equipment recommended for

[26] Industrial Minerals. Turkey. Private Find of Celestite. No. 58, July 1972, p. 29.

[27] American Ceramic Society Bulletin. V. 51, No. 4, April 1972, pp. 320–374.

[28] Formation of Thin Layers of Mixed Titanates by Solid-Solid Reactions. Amer. Ceram. Soc. Bull., v. 51, No. 5, May 1972, pp. 474–478.

[29] Prepared by J. Robert Wells, physical scientist.

[30] Ceramic Industry Magazine. Wollastonite. V. 100, No. 1, January 1973, p. 112.

efficiently fabricating them into ceramic tile, were discussed in a journal article.[31] Another article mentioned the advantages of using wollastonite in glazes for tile to prevent excessive bubble formation and still assure maturing of the ware within an accelerated firing cycle.[32] Experiments were carried out to study the preparation of materials with hydraulic setting properties by the calcination of calcium carbonate-silica mixtures produced either by carbonation of wollastonite and pseudowollastonite (a dimorphous form, also called betawollastonite), or alternatively by intergrinding precipitated $CaCO_3$ with SiO_2 flour.[33]

[31] Altschuler, Otto. The Ideal Tile Plant. Ceram. Ind. Mag., v. 99, No. 2, July 1972, pp. 36–37.

[32] Harkort, Dietrich, and Ulrich Hoffman. Germany Streamlines Firing Operations. Ceram. Ind. Mag., v. 99, No. 4, October 1972, pp. 26–29.

[33] Klemm, W. A., and R. L. Berger. Calcination and Cementing Properties of $CaCO_3$–SiO_2 Mixtures. J. Am. Ceram. Soc., v. 55, No. 10, October 1972, pp. 485–488.